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Emissions of Amphibole Asbestos from the Simulated Open Burning of Duff from Libby, MT

Office of Research and Development
National Homeland Security Research Center

NOTICE

The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development's (ORD) National Homeland Security Research Center (NHSRC), funded, directed and managed this work through Contract Number EP-C-09-027 with ARCADIS. This report has been peer and administratively reviewed and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use of a specific product.

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ABSTRACT

This report describes an experimental effort to support the mission of the U.S. Environmental Protection Agency's (EPA's) Region 8 by providing relevant information about the potential for exposure of firefighters to amphibole asbestos fibers in the event of a forest fire in the region of Libby, Montana. Libby is the location of a vermiculite mine where significant quantities of amphibole asbestos existed. Mining operations resulted in asbestos contamination around the vicinity of the mine, and Libby has been declared a Superfund site. These asbestos fibers are otherwise known as Libby Amphibole (LA) asbestos. Should a forest fire occur in Operable Unit 3 (OU3), it is possible that fibers in duff and bark may be released into the air, possibly resulting in inhalation exposures to U.S. Forest Service (USFS) workers fighting the fires, either on the ground or in the air and (depending on wind direction and meteorological conditions) might also result in exposure to residents of Libby. However, available data are not adequate to support reliable quantitative estimation of the air concentrations of asbestos fibers that may occur in smoke during a fire in OU3.

Due to difficulties in performing a test burn in the field that would result in uncontrolled emissions of LA being released into the atmosphere, it was decided that performing a laboratory-scale simulation of a wildfire involving LA-contaminated duff would yield emission factors that could be used to perform exposure assessments that would be based on measured emissions from a combustion environment. Some aspects of a real-world wildfire (e.g., upward motion of air due to convective motion) were not able to be simulated.

As part of the Remedial Investigation (RI) at OU3, this report describes a series of experiments performed at the EPA's Open Burn Test Facility (OBTF), located at the EPA facilities in Research Triangle Park, NC. These experiments involved making measurements of LA released from the burning of contaminated source material (duff) from OU3 in a series of controlled burns in the OBTF. The experiments were performed with the intent to simulate the temperatures encountered in wildfires that may impact the release of LA fibers; realizing that all the features of a wildfire might not be able to be simulated. The results of the OBTF study will be used by Region 8 with USFS models that predict smoke PM levels during fires to yield predicted concentrations of LA in air.

Under the conditions that were tested, fractions of phase contrast microscopy equivalent (PCME) asbestos fibers ranging from 88% to 105% (average = 92%) appear to remain behind in the residual bottom ash that remained after the burn was completed for the High Temperature burn conditions and fractions of PCME asbestos fibers ranging from 88% to 115% (average = 99%) appear to remain behind in the residual bottom ash that remained behind after the burn was completed for the Low Temperature burns. These observations suggest that the majority of the LA fibers that are present in the duff do not become entrained into the air emissions.

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ACRONYMS AND ABBREVIATIONS

AGO	Area of Grid Openings
APPCD	Air Pollution Prevention and Control Division
BTU	British Thermal Unit
CBR	Chemical, Biological, and Radiological
CEM	Continuous Emissions Monitor
COC	Chain of Custody
DAS	Data Acquisition System
DI	Deionized
DQI	Data Quality Indicator
DQO	Data Quality Objective
EFA	Effective filter area
EPA	United States Environmental Protection Agency
GO	Grid Openings
HASP	Health and Safety Protocol
HEPA	High Efficiency Particulate Air
LA	Libby Amphibole Asbestos
LOD	Limit of Detection
MCE	Mixed Cellulose Ester
NA	Not Applicable
NDIR	Non-Dispersive Infrared
NHSRC	National Homeland Security Research Center
NIST	National Institute of Standards and Technology
OBTF	Open Burn Test Facility

ORD	EPA Office of Research and Development
OSHA	Occupational Safety and Health Administration
OU3	Operable Unit 3
PCME	Phase Contrast Microscopy Equivalent
PM	Particulate Matter
PM_{10}	Particulate Matter Less Than or Equal to 10 µm
$PM_{2.5}$	Particulate Matter Less Than or Equal to 2.5 µm
PPE	Personal Protective Equipment
PPM	Parts per million; ppmv – parts per million on a volume basis; ppmm – parts per million on a mass basis
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
SHEMD	EPA’s Safety, Health, and Environmental Management Division
SOP	Standard Operating Procedure
TBD	To Be Determined
TC	Thermocouple
TEM	Transmission Electron Microscopy
TSA	Technical Systems Audit
UL	Underwriters Laboratories
USFS	United States Forest Service

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1.0 INTRODUCTION

This project supports the mission of the U.S. Environmental Protection Agency (EPA) by providing relevant information about the potential for exposure of firefighters to amphibole asbestos fibers in the event of a forest fire in the region of Libby, Montana. Libby is the location of a vermiculite mine where significant quantities of amphibole asbestos existed. Mining operations resulted in asbestos contamination around the vicinity of the mine, and Libby has been declared a Superfund site. These asbestos fibers are otherwise known as Libby Amphibole (LA) asbestos. The term "Libby Amphibole" is used in this document to identify the mixture of amphibole minerals, of varying elemental compositions (e.g., winchite, richterite, and tremolite), which have been identified in the rocks and ore of the vermiculite mine near Libby, MT, and are characteristic of the elongated structures commingled with the vermiculite mined at this location[1] (i.e., present in the ore vermiculite concentrate and processed materials). Releases of LA asbestos to the environment in Operable Unit 3 (OU3) of the LA Superfund Site have resulted in contamination of soil, duff, and tree bark in the area surrounding the mine. Disruption of the soil during a wildfire is expected to be minimal and largely confined to local areas where firebreaks and other trench-digging activity might be expected to occur, therefore the emphasis is on the combustion of duff, since it is directly exposed to the air, is impacted by flames from the fires, and can potentially be affected by the convective air currents created during a wildfire situation. Duff is defined as the biomass accumulated on the forest floor and consists mainly of shed vegetative parts such as leaves, branches, bark and stems existing in various stages of decomposition above the soil surface. Should a forest fire occur in OU3, fibers in duff and bark may be released into the air. This release of fibers could result in inhalation exposures to U.S. Forest Service (USFS) workers fighting the fires, either on the ground or in the air and (depending on wind direction and meteorological conditions) might also result in exposure to residents of Libby[2]. However, the data from the extensive characterization of the contamination and subsequent risk assessments are not adequate to support reliable quantitative estimation of the air concentrations of asbestos fibers that may occur in smoke during a fire in OU3.

Due to difficulties in performing a test burn in the field that would result in uncontrolled emissions of LA being released into the atmosphere, it was decided that performing a laboratory-scale simulation of a wildfire involving LA-contaminated duff would yield emission factors that could be used to perform exposure assessments that would be based on measured emissions from a combustion environment. Some aspects of a real-world wildfire (e.g., upward movement of gases due to convective forces) were not able to be simulated.

As part of the Remedial Investigation (RI) at OU3, this report describes a series of experiments performed at the EPA's Open Burn Test Facility (OBTF), located at the EPA facilities in Research Triangle Park, NC. These experiments involved making measurements of LA released from the burning of contaminated source material (duff) from OU3 in a series of controlled burns in the OBTF. The LA emissions that were used for developing emission factors from this study were the Phase Contrast Microscopy Equivalent (PCME) fibers, which are analyzed by Transmission Electron Microscopy (TEM) using the ISO 10312 method[3]. PCME fibers are defined as fibers with the following dimensions: length >5 µm, width >0.25µm, with an aspect ratio >3:1. The fiber dimensions are the equivalent to the size fiber that would be counted by a Phase Contrast Microscope to count fibers in an Industrial Hygiene setting. It should be noted that PCME structures are a subset of the total structures analyzed and reported by TEM analysis.

This effort was performed under a Category I Quality Assurance Project Plan (QAPP) that described the procedures and data quality objectives (DQOs) for the measurements of LA fibers per unit of particulate matter (PM) in smoke from burning contaminated material from OU3 under controlled conditions at the OBTF. The experiments were performed with the intent to simulate the salient features of a wildfire as much as possible; realizing that all the features of a wildfire might not be able to be simulated. The results of the OBTF study will be combined with USFS models that predict smoke PM levels during fires to yield predicted concentrations of LA in air[4].

The advantage of testing in a pilot-scale experimental facility is that the asbestos-containing materials can be contained fully and the combustion gases can be “cleaned” with particulate control equipment (a baghouse followed by a high efficiency particulate air [HEPA] filter to prevent asbestos from escaping into the environment).

The burning occurred in a Burn Chamber placed in an enclosed shed (the “Burn Hut”). There were two distinct experimental conditions: 1) a “High Temperature” condition intended to simulate the rapid combustion that occurs during a wildfire; and 2) a “Low Temperature” condition intended to simulate the smoldering combustion that occurs after the initial conflagration associated with a wildfire that has subsided. For the High Temperature tests, the Burn Chamber consisted of a grate with an up-fired propane burner to provide continuous high temperatures and flame radicals to a supply of duff that was replenished periodically. For the “Low Temperature” tests, the Burn Chamber consisted of a grate with a small propane torch (not the same burner used in the High Temperature tests) to sustain the burning of a pile of duff that was periodically replenished.

Duff was fed by gravity into the Burn Chamber and was replenished during the burn by the addition of new duff through a feed chute. Air for the fire was provided by a fan that blew measured quantities of air into the Burn Hut. Smoke from the burning material traveled through an exhaust flue, where sampling was performed for LA, PM, and standard combustion exhaust gases. Wherever possible, standard sampling and analytical methods were used.

2.0 CONCLUSIONS

Experiments were performed in EPA's OBTF to examine the potential for emissions of LA asbestos fibers from the simulated open burning of duff samples collected from OU3 near Libby, MT. The experiments were run in triplicate, and two different combustion conditions were examined (High Temperature flaming combustion and Low Temperature smoldering combustion).

Measurements were taken of combustion gases (O_2, CO, CO_2), total filterable particulate matter, $PM_{2.5}$, and asbestos fibers (airborne, residual ash, and wipe samples from the walls of the OBTF). The duff starting material was also analyzed for asbestos as well as being characterized as fuel using proximate and ultimate analyses. These measurements were combined with measurements of the mass of duff burned and various flow rates through the OBTF to generate an estimate of emission factors of fibers per PM (LA fibers per mass of duff burned divided by $PM_{2.5}$ in terms of mass emitted per mass of duff burned). The emission factors were combined to yield estimates of LA fibers per mass of $PM_{2.5}$. This modified emission factor can be linearly scaled based on measured quantities of LA fibers in the duff samples to yield estimates of LA fibers per mass of $PM_{2.5}$ as a function of distance from the Libby vermiculite mine. These emission factors are intended to be used by Region 8 to perform an exposure assessment of firefighting personnel that might be subjected to inhalation exposures of LA fibers should a wildfire occur in the vicinity of the vermiculite mine. The results may also be used to perform exposure assessments for the residents in and around Libby, MT.

Under the conditions that were tested, fractions of PCME asbestos fibers (the asbestos fibers that meet the dimensional characteristics to be of health concern) ranging from 88% to 105% (average = 92%) appear to remain behind in the residual bottom ash after the burn was completed for the High Temperature burn conditions and fractions of PCME asbestos fibers ranging from 88% to 115% (average = 99%) appear to remain behind in the residual bottom ash after the burn was completed for the Low Temperature burns. These recovery estimates are based on total numbers of LA fibers. It should be noted that having recovery numbers greater than 100% do not mean that there was more asbestos at the end of the experiment than there was at the beginning. It just means that the calculations resulted in numbers greater than 100%, mostly due to analytical variability between various terms in the calculations that are based on analysis (e.g., LA in ash, LA in duff). These observations suggest that the majority of the LA fibers that are present in the duff do not become entrained into the air emissions.

It must be emphasized that the emission factors generated in these tests represent results from a laboratory simulation of a large, wide-area incident that might potentially involve hundreds, or maybe thousands of acres of forest being involved in a wildfire. There are fluid mechanical phenomena that occur at the full-scale that are unable to be reproduced in a small-scale laboratory burn. In addition, the materials involved in a real wildfire incorporate the bark and trunks of trees, the duff, and perhaps the soil in the affected area. This simulation sacrificed some of the realism of a full-scale wildfire, in order to tightly control the variables that the authors determined to be the most important, based on available literature, sampling data from OU3, and their expert judgement. It is expected that the results generated from this study fall within an order of magnitude of results that would be generated from a full-scale field sampling effort, if one could be performed.

3.0 METHODS AND MATERIALS

3.1 Experimental Objectives

The goals of this series of tests were:

- To provide emission factors of LA fibers and PM less than or equal to 2.5 µm ($PM_{2.5}$) to air during a simulated open fire of duff collected from OU3;
- To provide estimates of the partitioning of LA fibers between air emissions and ash; and
- To determine how sensitive the results (both LA and $PM_{2.5}$ release) are to burn temperatures.

The DQO for these tests was that measurements of LA and $PM_{2.5}$ in the residual ash and air emissions should be of sufficient precision and accuracy to allow EPA Region 8 to use the data for an exposure assessment of USFS personnel who might operate in the vicinity of a forest fire near Libby, MT.

3.2 Critical Measurements

The following measurements were deemed to be critical to accomplish the experimental DQO:

- Sample volume (dry basis);
- Exhaust duct volumetric flow rate (dry basis);
- Exhaust duct moisture level;
- Weight of the burned material;
- Run time, including sample times, feed times, and total burn time;
- $PM_{2.5}$ filter weight;
- Concentration of LA associated with $PM_{2.5}$;
- Concentration of LA in the duff that was burned;
- Burn temperatures; and
- Exhaust duct temperatures.

The range of LA concentrations that would occur in Burn Chamber smoke was not known *a priori*. The analytical requirements for LA measurements reported in Section 4.2 are such that concentrations of LA fibers in Burn Chamber smoke could be reliably detected and quantified if they were present. Table 3-1 lists the performance criteria for critical measurements, as well as the methods that were used and relevant Quality Assurance/Quality Control (QA/QC) consideration.

Table 3-1. Performance Criteria for Critical Measurements.

Measurement Parameter	**Sampling Method(s)**	**Calibration/Certification**	**Analysis Method**	**QA/QC Criteria**	**Completeness**
Burn Hut Exhaust Velocity Traverses	EPA Method 1A[5]	N/A	N/A	N/A	100%
Burn Hut Exhaust Volumetric Flow Rate	EPA Method 2C[6] (to be performed in conjunction with M201A[7])	Standard Pitot tube	Manometer	± 5% of actual value	100%
		Gas temperature	K-Type Thermocouple	± 2 °F (± 1 °C)	
Burn Hut Exhaust Moisture Content	EPA Method 4[8] (to be performed in conjunction with EPA Method 201A[7])	Volume of gas is compared to National Institute of Standards and Technology (NIST)-traceable dry gas meter before/after the sampling campaign	Standard Meter Comparison	Leak rate less than 4% of the average sampling rate	100%
		Balance calibration check	NIST-traceable Class S weights	± 0.5g	100%
Sampling Time	Stopwatch	Compare against NIST Official U.S. time	N/A	±1 min/30 days	100%
Burn Hut Exhaust $PM_{2.5}$	EPA Method 201A[7]	Volume of gas is compared to NIST-traceable dry gas meter before/after the sampling campaign	Standard Meter Comparison	Leak rate less than 4% of the average sampling rate	67% (minimum 4 of 6)
				90 to 110% isokinetic flow	100%
		Balance calibration check	Gravimetric S-Class weights	± 0.1 mg	100%
Burn Hut Exhaust Asbestos Sampling	EPA Asbestos Sampling Standard Operating Procedure (SOP) #2015[9]	Post-test meter calibration check	Standard Meter Comparison	± 5% of pre-calibration	67% (minimum 4 of 6)
	Modified EPA Method 5[10] (no filter)	Volume of gas is compared to NIST-traceable dry gas meter before/after the sampling campaign	Standard Meter Comparison	Leak rate less than 4% of the average sampling rate	100%
Asbestos Analysis of LA in Emitted Sample Material	SOP DUFF-LIBBY-OU3[11]	N/A	Transmission Electron Microscopy (TEM)	20-25 fibers per sample being optimal	100%
Temperature	N/A	Compare against a NIST-traceable thermometer	K-type thermocouple	± 2 °F(± 1 °C)	100%

N/A – not applicable

3.3 Secondary Measurements

The following measurements that characterize the burn conditions and characteristics of the smoke are less vital, but are important to help understand what factors influence the release of LA into smoke. These measurements and the tolerable levels of potential errors associated with data collection as well as the limitations of the use of the data are listed in Table 3-2.

- Exhaust duct oxygen (O_2);
- Exhaust duct carbon dioxide (CO_2);
- Exhaust duct carbon monoxide (CO);
- Weight loss;
- Total filterable PM;
- Mass of ash;
- Concentration of LA in ash; and
- Inlet duct flow.

Table 3-2. Performance Criteria for Secondary Measurements.

Measurement Parameter	**Sampling Method(s)**	**Sub-parameter**	**Analysis Method**	**Acceptance Criteria (% Bias)**	**Completeness**
Burn Hut Exhaust CO_2/O_2	EPA Method 3A[12]	Calibration error	Instrumental calibration gases	± 2%	90% of test periods
		Sampling system bias		± 5%	
		Zero & calibration drift		± 3%	
Burn Hut Exhaust CO	EPA Method 10[13]	Calibration error	Instrumental calibration gases	± 2%	90% of test periods
		Sampling system bias		± 5%	
		Zero & calibration drift		± 3%	
		Sampling system bias		± 5%	
		Zero & calibration drift		± 3%	
Weight Loss	N/A	Scale calibration check	Gravimetric S-class weights	± 10 g	100%
Burn Hut Inlet Volumetric Flow Rate	EPA Method 2C[6]	Standard Pitot tube	Manometer	± 5% of actual value	100%
		Gas temperature	K-Type Thermocouple	± 2 °F(± 1 °C)	
Asbestos Analysis of LA in Ash	SOP DUFF-LIBBY-OU3[11]	N/A	Transmission Electron Microscopy (TEM) using ISO 10312[3]	20-25 fibers per sample being optimal	100%

NA – Not Applicable

3.4 Special Training/Certification

Asbestos is a hazardous substance that can increase the risk of cancer and serious non-cancer pulmonary diseases in people who are exposed by inhalation. All personnel involved in handling, burning, and collecting samples during a testing sequence of the burn material from OU3 required Occupational Safety and Health Administration (OSHA) 40-hour health and safety training, and wore appropriate personal protective equipment (PPE).

EPA's Safety, Health, and Environmental Management Division (SHEMD) performed air monitoring around the OBTF before, during, and after the burn of the material from OU3 to evaluate the potential for any fugitive emissions of asbestos during the testing. SHEMD also did personnel monitoring to assess the potential for worker exposure to asbestos.

3.5 Chain of Custody

A chain of custody (COC) record accompanied the samples. In the transfer of custody, each custodian signed, recorded, and dated the transfer. All samples of asbestos collected as part of this project were sent for preparation and/or analysis at EMSL Analytical, Inc.

3.6 Sampling Process Design (Experimental Design)

Burns were initiated by starting a propane burner or torch and successively adding the source material, while the burner/torch continued to operate throughout the duration of the experiment. The testing was designed to collect and characterize the emissions from burning these materials under conditions that simulate open-burn conditions found in a wildfire. The continuous operation of the burner/torch was justified based on the fact that in a real wildfire, any control volume of solid material that was burning would be continually exposed to heat from adjacent control volumes of burning material. By doing this, the fluctuations in the burn are minimized that might occur at the small-scale due to the burn charges being periodically extinguished. Combustion performance was evaluated by Continuous Emission Monitor (CEM) measurements of the exhaust flue gas concentrations, and by fuel bed temperatures as measured by thermocouples (TCs). Samples included the feed materials, the combustion residue ash, the PM, and the criteria pollutants in exhaust gases (O_2, CO_2, CO). Airborne asbestos, if any, was determined by analyzing samples collected in the exhaust duct using two simultaneous sampling techniques: The first method was based on a Modified EPA Standard Operating Procedure (SOP) for asbestos sampling[9], and the second was based on a modified EPA Method 5 sampling train[10]. See Section 3.15 for more detail on sampling methods. Temperatures in a wildfire can range from near-ambient, to temperatures greater than 2012 °F (1100 °C)[14]. The experimental objectives to identify the potential temperature dependency of LA emissions from duff combustion where balanced by budgetary limitations, which necessitated selecting a limited number of conditions to test. Therefore it was decided to test at two temperature conditions, defined as Low and High temperature conditions. The actual temperatures selected as Low and High temperatures were largely determined by the temperatures that were achievable by the experimental apparatus when operating within other logistical constraints (feed rate, need for continuous burner/torch operation). The test matrix consisted of two sampling conditions (High Temperature ~ 1800 °F (982 °C), and Low Temperature ~ 800 °F [427 °C]) and was carried out in triplicate to allow the variability in the results to be assessed. Hot blanks (propane burning only) were performed to determine the baseline measurements for the tests. Table 3-3 summarizes the test matrix and the samples that were collected to achieve the test objectives.

Table 3-3. Sampling and Measurement Test Sequences.

	OU3 Duff Material	**Burn Hut Exhaust O_2, CO, CO_2**	**Grate Temp**	**Burn Hut Exhaust Flows**	**$PM_{2.5}$**	**Burn Hut Exhaust Asbestos**	**Ash Asbestos**	**Burn Hut Wall Wipe Sample Asbestos**
Test Duration	~90 min.	Cont.	Cont.	Cont.	~60 min.	~ 60 min	-	-
Scoping	✓	✓	✓	✓	-	-	-	-
First Hot Blank Sample Collection	-	✓	✓	✓	✓(1)	✓(1)	N/A	-
High Temperature Setting	✓	✓	✓	✓	✓(3)	✓(3)	✓(3)	-
Hot Blank Sample Collection	-	✓	✓	✓	✓(1)	✓(1)	N/A	✓(6)
Low Temperature Setting	✓	✓	✓	✓	✓(3)	✓(3)	✓(3)	-
Hot Blank Sample Collection	-	✓	✓	✓	✓(1)	✓(1)	N/A	✓(6)

✓: Testing performed; **-** : Testing not performed, ✓(n): (number of replicates)

TBD – to be determined

N/A – Not applicable

3.7 Open Burn Test Facility

3.7.1 Burn Hut

The OBTF was designed and constructed using various readily available standard building elements. The building includes an enclosed burn region adjacent to a covered sampling area where sampling equipment is protected from direct sun or rain. The basic structure is composed of pre-coated sheet metal fitted to a frame of structural galvanized square tubing. Base rails that are anchored to the concrete pad support the walls. The sheet metal walls are attached to the square tubing frame by self-tapping Tek screws. This structure is commonly used as a workshop or carport, and, for the standard design, the design wind load is 90 mph with a roof live load of 293 kg/m^2 (60 lb/ft^2). This design was modified by the addition of vertical wall studs to match the dimensions of sheetrock wall board. The door is a standard 36 in. (91 cm) wide model offered for this shed. The window is a standard unit about 24 in. (61 cm) wide, but the glass was replaced by 3/16 in. (0.48 cm) thick NeoCeram®, a clear ceramic material used in woodstoves. The OBTF is designed to withstand 799 °C (1470 °F) in continuous operation and has passed the Underwriters Laboratories (UL)-1482 Impact Test[15]. This material has a low coefficient of thermal expansion and will not create dangerous pressure within its mounting frame. The interior was finished in 5/8 in. (1.6 cm) thick sheetrock that also forms the backing to which aluminum foil can be attached. For these tests, the walls were lined with aluminum foil, and in between each test condition, the foil was removed and replaced. The wallboard seams were taped and spackled as in standard house applications. The board was not painted. In general, volatile agents were avoided or other materials were substituted. The final coating is a certified (ASTM B-479[16]) clean aluminum foil (Ultra-High Vacuum) purchased from All Foils, Inc. The floor is made of 30.5 cm x 30.5 cm (1 ft x 1 ft) paving stones supported by the underlying concrete pad to shield the scales from direct heat. A schematic diagram of the Burn Hut is shown in Figure 3-1.

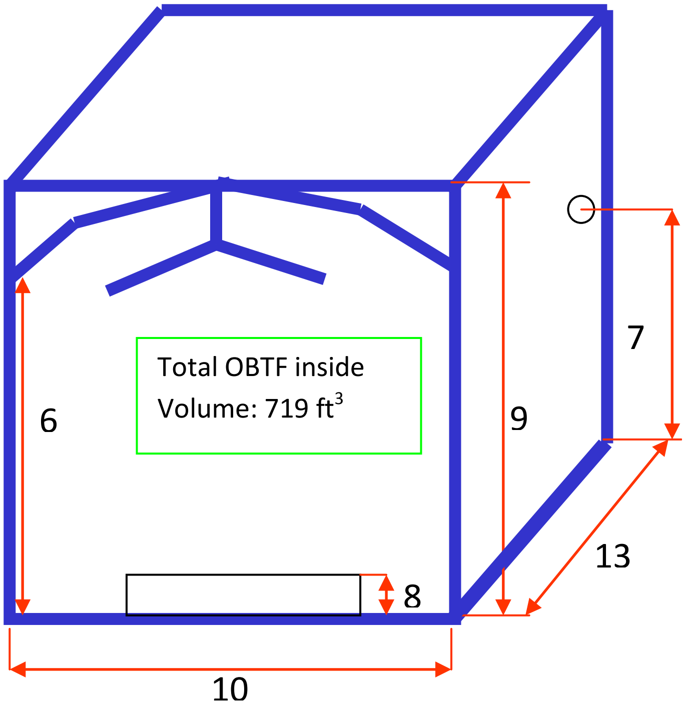

Figure 3-1. Burn Hut Internal Dimensions (Dimensions in feet; not to scale).

3.7.2 Feed Chute

In order to maintain the burn conditions for the minimum time to perform necessary asbestos and PM sampling (approximately 1-hour) without 1) producing excess temperatures in the exhaust duct that would exceed baghouse operating temperatures; and 2) having the sampling period represent a period of time when the duff was burning and not reflect a very short time where the duff might burn out and then either smolder or be completely combusted ash, the material needed to be intermittently fed into the Burn Chamber over a nominal 1-hour period of time. The gas temperature in the exhaust duct leaving the Burn Hut during a test can exceed 200 °F (93 °C). The gas can also be laden with fly ash and asbestos particles. For safety reasons, it was not advisable for the OU3 material loading operation to require a test operator to enter into the Burn Hut. In addition, opening and closing the Burn Hut access door will introduce disturbances to the temperature and gas flow conditions inside the Burn Hut and will create poorly characterized burning conditions. A round opening was therefore created on one side wall of the Burn Hut to allow a stainless steel pipe to be installed and function as a feed chute (Figure 3-2). With the feed ram retracted, the OU3 material charge was placed into the receiver opening of the chute. The feed ram was then manually pushed in to deliver and drop the charge into the burner setup.

Figure 3-2. Fuel Feed Ram and Chute.

3.7.3 Burn Chamber

The release rates of LA and/or PM may depend on temperature. A real-world wildfire contains temperature environments ranging from near-ambient conditions to temperatures exceeding 2000 °F (1093 °C). The two temperatures used in these experiments were selected based on 1) the desire to have two temperatures that were significantly different from each other in order to identify a temperature dependency, if one existed; and 2) the experimental constraints of not exceeding the baghouse inlet temperature and having an open burning combustion process occurring inside an uninsulated environment where heat transfer would prevent achieving very high temperatures. This dependence on temperature was investigated by performing burns at two temperature settings: Low (~ 800 °F [427 °C]) and High Temperature ~ 1800 °F (982 °C). The configuration of the Burn Chamber was slightly different for the two conditions.

3.8 High Temperature Setup

The Burn Chamber, shown in Figure 3-3 consisted of a stainless steel enclosure (dimensions: 30.5 cm (1 ft) W x 30.5 cm (1 ft) L x 91.3 cm (3 ft H)) sitting on the top of a 10-inch diameter cast iron propane-fired burner capable of developing 320,000 BTU/hr of heat (32-Jet Nozzle Cast Iron 25.4 cm (10-inch) Jet Burner http://www.tejassmokers.com/newproducts_page6.htm). The propane-fired burner is capable of maintaining the desired high combustion temperature of the duff. A smaller burner was tested initially, but was unable to achieve sufficiently high temperatures to reach the targeted High Temperature test condition. A 25.4 cm (10-inch) diameter (30.5 cm (1 ft) high) metal mesh screen basket, with a mesh screen bottom was placed inside the combustion chamber to allow the combustion of the duff bags and the removal of the ash after each burn.

Figure 3-3. High Temperature Condition Burn Chamber.

3.9 Low Temperature Setup

The Low Temperature setup (Figure 3-4) consisted only of the 10-inch (25.4 cm) diameter (1 ft [30.5 cm] high) metal mesh screen basket, with a mesh screen bottom sitting on the scale. This condition intended to mimic a smoldering biomass combustion scenario. A propane torch was used to keep the burn going throughout the testing sequence.

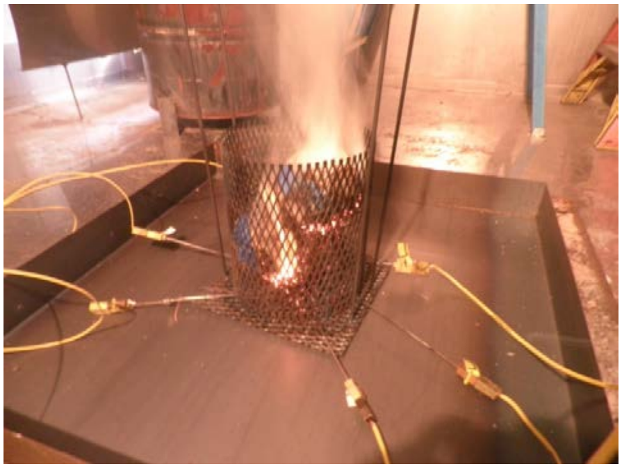

Figure 3-4. Low Temperature Condition Burn Chamber.

The Burn Chamber was fitted with four K-Type TCs inserted in a radial fashion at about 1-inch (2.54 cm) above the top of the grate to measure temperatures of the burning mass of material. The Burn Chamber was mounted on a scale with a resolution of about ± 0.1 lb (0.454 kg) to continuously monitor the mass of the fuel remaining. The propane tank is not mounted on this scale, so the loss of propane during the burn will not confound the mass measurements.

3.10 Burn Hut, Baghouse and HEPA Filter

Smoke from the burning material traveled through an exhaust flue gas duct, where sampling for LA and PM was performed. The duct was connected to a baghouse Model 72RT-21 manufactured by MAC Equipment and HEPA filters to avoid any LA release to the atmosphere. The HEPA filter (AstrolCel I Model 905-000-348) has dimensions of 24 inch x 24 inch x 11 ½ inch (61 cm x 61 cm x 29.2 cm) and was specifically installed in preparation for these tests to ensure that no asbestos would escape into the atmosphere. The HEPA filter was rated for a maximum service temperature of 93 ^{o}C (200 °F) and has an efficiency of 99.99% for 0.3 µm particles. Figure 3-5 shows the Burn Hut, exhaust duct work and the baghouse and the HEPA filter.

Figure 3-5. Burn Hut, Baghouse, and HEPA Filter.

3.11 Burn Material

Based on initial discussions with EPA Region 8, the source materials most likely to release LA to air during a fire in OU3 appeared to be duff and bark. Duff is defined as the biomass accumulated on the forest floor and consists mainly of shed vegetative parts, such as leaves, branches, bark and stems existing in various stages of decomposition above the soil surface[17]. During an authentic wildfire, the principal material that is burned is duff and small woody debris, while bark on large standing trees (the likely primary location of embedded LA fibers) is usually only charred. In addition, available data collected during earlier duff LA sampling efforts by EPA Region 8[11] indicate that the levels of LA (mass per unit mass) are likely to be much higher in duff than in bark[18] (0.52% vs. 0.0026% over average of 6 samples). The main source of LA released to air during a fire was considered most likely to be duff. For this reason, the study focused exclusively on duff as the burn material.

Pre-packaged 227 g ± 45.3 g (0.5 ± 0.1 lb) duff samples were shipped to EPA's Research Triangle Park, NC facilities in large shipping containers (e.g., 208 Liters (55-gallon) cardboard drums, lined with plastic). The duff collection, homogenization, handling and shipping were performed according to the Libby OU3 QAPP Section B1.1 and B3, respectively[19].

The duff material was collected by EPA Region 8 at a location in relatively close proximity to the vermiculite mine, with already-measured concentrations of LA fibers. Out of the approximately 300 bags of duff collected, four bags of duff were selected at random from the lot of material collected in OU3, and these bags were submitted to the analytical laboratory for LA analysis by TEM[3] (ISO 10312). The results from this analysis are shown in Table 3-4. Each bag was dried and ashed, and the residue was suspended in water and applied to a filter for examination by TEM, with the PCME asbestos fibers being the primary asbestos measurement since the PCME fibers are the ones of health concern by the EPA. Based on the average of the four replicate samples, the concentration in duff was 160 million (1.6 x 10^8) PCME fibers per gram of duff (dry weight).

Table 3-4. LA Fibers in Duff Material.

Parameter	**Unit**	**Replicate**				
		1	**2**	**3**	**4**	**Mean**
Mass of duff	g (as received)	209.15	214.68	212.15	210.4	211.6
Mass of duff	g (dry wt)	198.60	204.1	200.91	198.77	200.6
Ratio	dry wt/wet wt	0.95	0.95	0.95	0.94	0.95
Mass of ash	g	121.97	128.5	113.49	114.9	119.7
Ratio (ash / duff)	g ash/g duff dry wt	0.61	0.63	0.56	0.58	0.60
Effective Filter Area (EFA)	mm^2	1286	1286	1286	1286	1286
Grid Openings (GO)	--	4	4	5	4	4
Area of Grid Openings (AGO)	mm^2	0.0132	0.0132	0.0132	0.0132	0.0132
Mass suspended	g	0.25	0.25	0.25	0.25	0.25
Susp vol	mL	100	100	100	100	100
Vol filtered	mL	0.3	0.5	0.5	0.5	0.045
F Factor	--	0.003	0.005	0.005	0.005	0.0045
N	total LA s	77	69	61	62	NA
	PCME LA s	12	8	16	14	NA
Ratio (PCME / Total)	Structures per structure (s/s)	16%	12%	26%	23%	19%
Concentration in ash from duff	Total LA s/g ash	2.5 x 10^{9}	1.34 x 10^{9}	9.51 x 10^{8}	1.21 x 10^{9}	1.50E+09
	PCME LA s/g ash	3.9 x 10^{8}	1.56 x 10^{8}	2.49 x 10^{8}	2.73 x 10^{8}	2.67E+08
Concentration in duff	Total LA s/g duff (dry wt)	1.54E+09	8.46E+08	5.37E+08	6.98E+08	9.04E+08
	PCME LA s/g duff (dry wt)	2.39E+08	9.81E+07	1.41E+08	1.58E+08	1.59E+08

NA – not applicable

The average values were used throughout the calculations, since the exposure assessment calculations require the use of average values, therefore the variability in the emissions across replicate runs was not considered in the emission factor calculations other than as an indicator of the reproducibility of the experiments. The duff was subjected to a proximate and ultimate analysis, the results of which are shown in Table 3-5. Note that the ash % reported in Table 3-5 does not match the ash % reported in Table 3-4, since Table 3-5 represents completely combusting the sample to find out how much inorganic content there is, whereas the residual ash reported in Table 3-4 contained a considerable amount of unburned carbon.

Table 3-5. Proximate and Ultimate Analysis of Duff Material.

Analysis	**Method***	**Result (Mass basis)**	**Basis**
Ash	ASTM D3174-11[20]	36.34 %	Dried and Ground
Volatile Matter	ASTM D3175-11[21]	49.65 %	Dried and Ground
Loss on Drying (LOD)	ASTM D3173-11[22]	9.00 %	As Received
Fixed Carbon (Calculated)	Calculation	14.01 %	Dried
C : Carbon	GLI Procedure ME-12	34.064 %	Dried and Ground
		34.165 %	
Cl : Chlorine	GLI Procedure ME-4A	240 ppm	Dried and Ground
Oxygen by difference	Calculation	27.47 %	Dried
H : Hydrogen	GLI Procedure ME-12	4.140 %	Dried and Ground
		4.133 %	
N : Nitrogen	GLI Procedure ME-12	0.970 %	Dried and Ground
		0.856 %	
S : Sulfur	GLI Procedure E16-2	< 0.05 %	Dried and Ground
Grind	GLI Procedure G-8	Completed	Dried

* GLI Methods are Galbraith Laboratories, Inc. internal methods.

3.12 Amount of Material

Desired burn conditions involved having a batch of material nearly completely combusted prior to feeding the next batch of material. Feeding too rapidly would cause material to accumulate in the Burn Chamber and possibly produce temperatures in the Burn Hut exceeding safe operating temperatures. Feeding too slowly would result in significant portions of the sampling duration to elapse while no duff combustion was occurring. Previous experimental studies from the OBTF[23] suggested that a burn rate of about 10 pounds per hour might be appropriate in order to prevent the heat of combustion inside the Burn Hut from resulting in flue gas temperatures in excess of 200 °F (93 °C) at the inlet to the baghouse. Based on this experimental study and assuming burn duration of approximately one hour, the mass of duff required per burn was calculated to be approximately 10 pounds (4.5 kg).

3.13 Test Conditions

Burns were initiated by starting the propane burner and stabilizing its operation for 5 minutes

(High Temperature setting) or using a propane torch. Combustion was sustained for both Low and High Temperature settings by adding two bags for the former and one bag for the latter at regular intervals (every 5 min). For convenience and also for safety, the duff was added packaged in paper bags and was not removed from the bags. The mass of paper (~7.5 g) in the bags was small (~3.3%) compared to the mass of duff, and was not expected to substantially influence the emissions of $PM_{2.5}$. The temperature at which the material is burning may influence the release of both LA and PM. The Low Temperature conditions were expected to be around 430°C (800°F) and the High Temperature conditions were expected to be around 980 °C (1800 °F) or higher.

3.13.1 Scoping Test

To identify appropriate operating scenarios to achieve the High Temperature and Low Temperature combustion conditions, a short series of scoping tests was run, using duff material collected on the EPA's Research Triangle Park campus. The duff that was collected was anticipated to be at least qualitatively similar to the duff from the vicinity of the Libby, MT, vermiculite mine.

Figure 3-6 shows the propane-fired burner that ended up being used for the High Temperature tests following the series of scoping tests. Figure 3-7 shows a photograph of the Burn Chamber that ended up being used for the High Temperature combustion conditions. Note the Type-K TCs mounted in a radial manner at the base of the Burn Chamber.

Figure 3-6. Photograph of Propane-Fired Ring Burner.

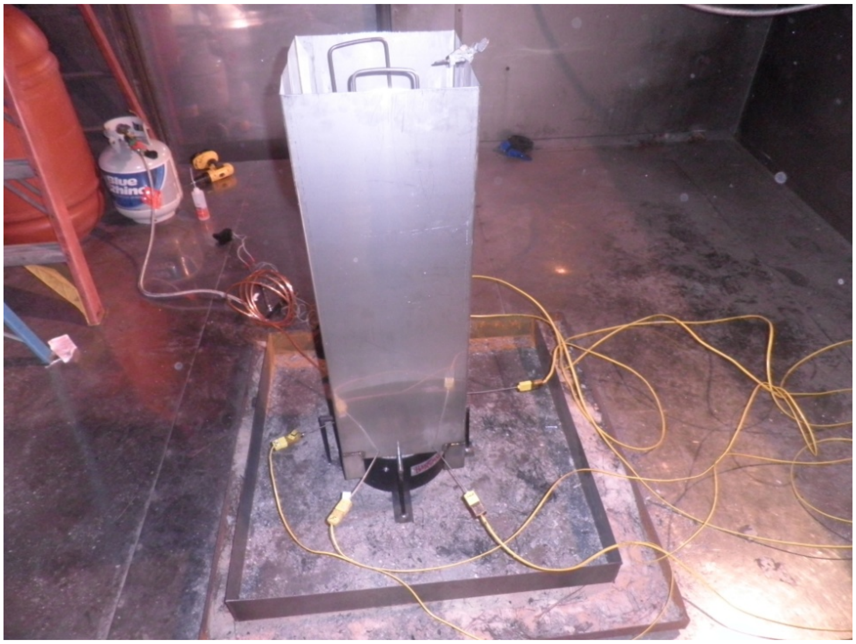

Figure 3-7. Photograph of Burn Chamber for High-Temperature Conditions.

Figure 3-8 shows the maximum and minimum temperatures as recorded by Three out of four TCs (one of the TCs was not laying down on the grate properly) as bags of duff were fed into the Burn Chamber for the test conditions eventually identified as the High Temperature test conditions for the experiments. There is a slight variation between the TCs measurements, probably due to their locations on the grate with respect to the burner and with respect to the location where the bags land. Figure 3-9 shows a photograph of the duff burning during the conditions identified during this scoping test. The maximum temperature was used to assess whether or not the target temperature was achieved to establish the High Temperature condition.

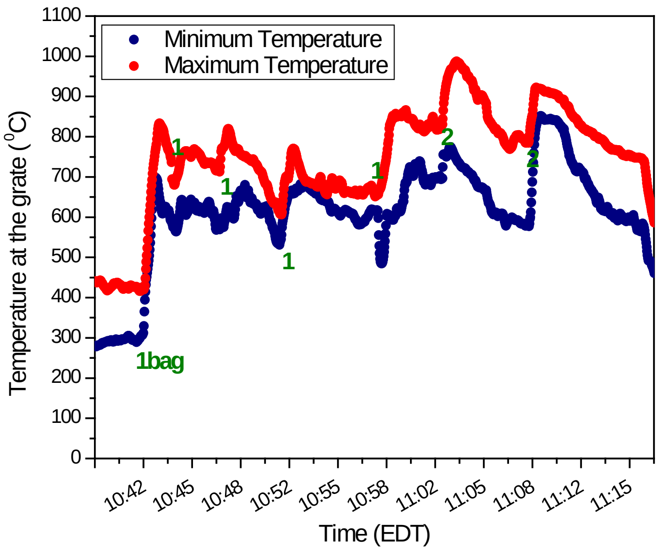

Figure 3-8. Grate Temperatures for Duff Combustion — High Temperature Scoping Test.

Figure 3-9. Photograph of Duff Combustion — High Temperature Scoping Test.

The operating scenario eventually decided upon for the Low Temperature conditions involved using a mesh cage in which to perform the duff combustion as a pile. Figure 3-10 shows the minimum and maximum temperatures measured for an actual Low Temperature test and Figure 3-11 shows a photograph of the duff combustion during the Low Temperature test conditions. A rather large variation among the temperature measurements on the top of the grate were observed during this test. This effect seems to be more accentuated than for the High temperature conditions setting where the propane-fired burner and the stainless steel enclosure provided a more uniform temperature setting on the grate. For the Low Temperature conditions, the location where the bags land and ignite provided necessarily higher temperatures reading in the burn basket. The target temperature conditions were met at the grate midway through the test.

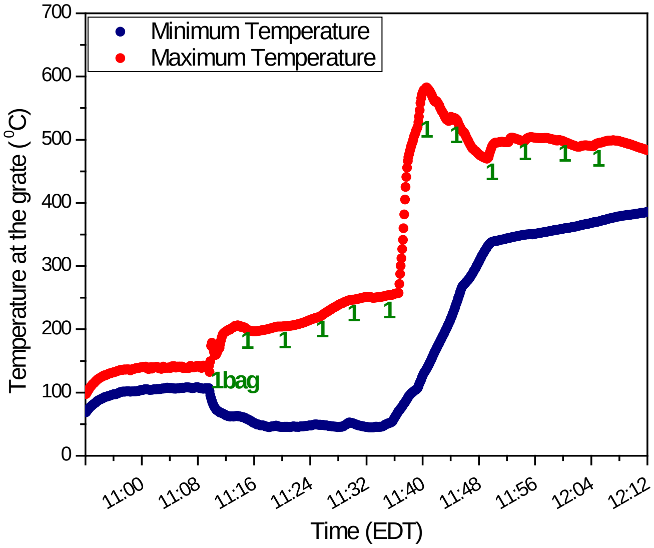

Figure 3-10. Grate Temperatures for Duff Combustion — Low Temperature Scoping Test.

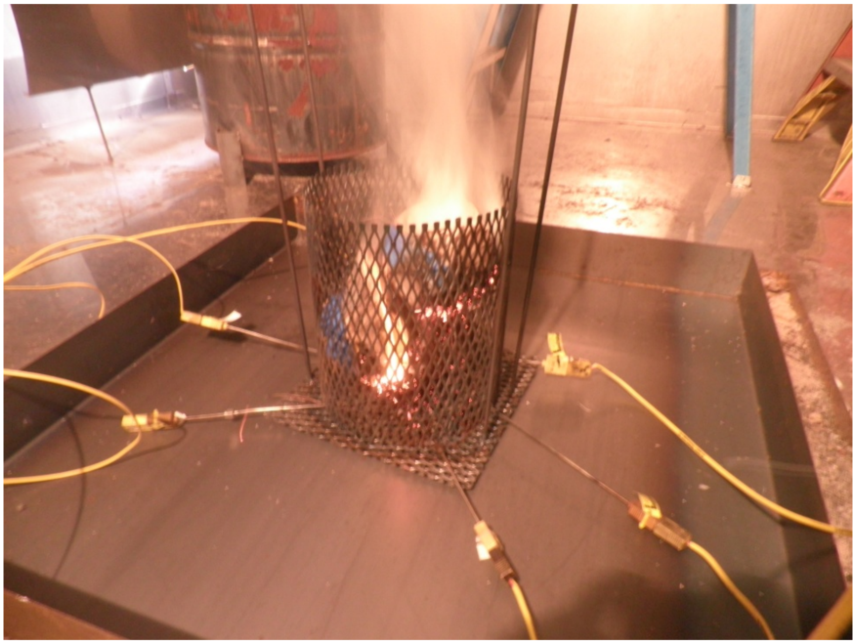

Figure 3-11. Photograph of Duff Combustion — Low-Temperature Scoping Test.

3.14 Test Procedures

3.14.1 Burn Hut Preparation and Post-Test Cleanup

It was necessary to prevent cross contamination of test samples between the two conditions

(Low and High Temperature). It was also crucial to minimize the opportunity for fugitive release of asbestos-containing particles during and after the tests. Therefore, before the first High Temperature test and after the last Low Temperature test, the inside of the Burn Hut was cleaned according to the following procedures.

- Don PPE approved for working in an asbestos-containing environment;
- Remove aluminum foil lining, store the removed foil in drums designated for storing and shipping asbestos-containing waste. (After removal from the wall, the aluminum foil was folded in half with the exposed surface folded in, and folding continued until the foil could fit into a 55-gallon asbestos-labeled drum.)
- Remove loose particulate materials from all internal surfaces using a vacuum cleaner (Omega Vac) designed for removal and capture of asbestos and toxic dust. A new vacuum filter and a clean inlet hose were used for each clean up event to reduce the opportunity for sample cross-contamination;
- Collect vacuum cleaner catch into a labeled glass jar for archive and possible analysis; and
- Reline the walls with new aluminum foil.

3.14.2 Control of Combustion Conditions

The temperature of the burn was controlled by adjusting the flame of the propane burner for the High Temperature conditions, or using a propane torch for the Low Temperature conditions. Target temperatures were approximately 800 ºF (425 ºC, Low Temperature) and 1800 ºF (982 ºC, High Temperature). These target temperatures are within the high and Low Temperature range expected from a wildfire. Although this range might not fully encompass the temperatures that may occur during authentic wildfires, within experimental limitations and recognizing the lack of being able to perform open air burning of LA-contaminated material at the field-scale, it was determined to likely be adequate to determine sensitivity of the LA and $PM_{2.5}$ emissions to burn temperatures and combustion mode (flaming or smoldering).

3.15 Sampling Methods

3.15.1 LA Combustion Exhaust Sampling Method

No validated sampling methods are available for measurement of asbestos from combustion sources. Methods exist for measurement of asbestos in ambient air, and methods exist for measurement of PM in stack gases. Therefore, to quantify the LA fibers in the smoke from the exhaust duct, multiple hybrids of ambient asbestos methods coupled with stack PM measurement methods were adapted and used so that acceptable samples could be acquired and analyzed in spite of the lack of validated sampling methods. LA in Burn Chamber smoke was sampled using two different techniques to ensure that LA data were acquired in the event that the non-standard sampling environment made the standard method fail. The two sampling methods used were: 1) the Mixed Cellulose Ester (MCE) Filter Method (the standard for ambient measurement of asbestos); and 2) the Impinger Method (a variant on stack sampling methods).

3.15.1.1 MCE Filter Method

The MCE filter method is based on a Modified EPA SOP for asbestos sampling[9]. The modification consists of using a Volatile Organic Sampling Train with a dry gas meter instead of a personnel sampling pump. This SOP provides procedures for asbestos air sampling by drawing a known volume of air from the exhaust flue gas and passing it through an MCE filter

(25 mm diameter, 0.8 µm pore size). The filter was then sent to a laboratory and analyzed by TEM, as specified in Section B.4.1 of the Libby OU3 Burn Chamber QAPP[19].

The sampling port for the MCE filters was selected at a location in the exhaust flue where gas temperatures are sufficiently low that neither the filter nor the filter cassette would be damaged by high temperatures. Sampling occurred using a flow rate of 5.1 ± 0.2 liters/min for the High temperature setting conditions and a sampling time of 15 minutes per sample. The flow rate through the filter was monitored during sample collection. If the flow began to decrease due to filter plugging with PM before 15 minutes, the filter would be changed more frequently, so that the target flow rate would be maintained during the entire hour of sampling. To better encompass the entire burn period, an additional MCE filter sample was acquired during the Low Temperature burn conditions during the 15 minutes after duff ceased to be fed. This scheme for sample collection resulted in collection of four MCE filters per 1-hour burn under the High Temperature conditions, and five MCE filters per 1-1/4 hour burn under the Low Temperature conditions, with an average volume for each sample of 76.4 ± 3.4 liters per filter.

It should be noted that initially the MCE filter housing was positioned in the duct perpendicular to the flow as per the recommendations of the method (this is contrary to probe positioning for stack sampling). The initial results from the tests under High Temperature conditions showed measurable asbestos fibers in the impingers (see Section 3.15.1.2), but none on the MCE filters. These results led to the assumption that the MCE filters may not have sampled isokinetically to allow the capture of the LA fibers using the filters perpendicular to the flow. A new sampling scheme (Figure 3-12) with the filter housing pointed into the flow to allow isokinetic sampling for the MCE filters was designed and used for the Low Temperature tests.

The revised sampling scheme for the Low Temperature tests consisted of attaching a 7.6 cm (3-inch) long, 3.175 mm (0.125-inch) diameter stainless steel nozzle (see Figure 3-13) to the MCE filter inlet using a specially manufactured O-ring fitting. This nozzle/filter assembly was directly inserted into the duct effluent through a port drilled in the side of the duct as shown in the attached drawing. Rigid tubing and fittings were used on the outlet of the filter to keep the assembly straight in the duct. Flexible tubing was used between the rigid tubing outlet and the pump/meter box. The target air flow rate passing through the MCE filter (25 mm diameter, 0.8 um pore size) to ensure isokinetic sampling using this sampling scheme was 8.5 ± 0.5 L/min. Four MCE filters were sampled per 1-hour burn, with a total volume of 128 ± 7.9 liters per filter. An additional MCE filter was sampled for 15 minutes following completion of feeding the duff, providing for an additional 129.4 ± 2.9 liters of sample of “smoldering” combustion effluent.

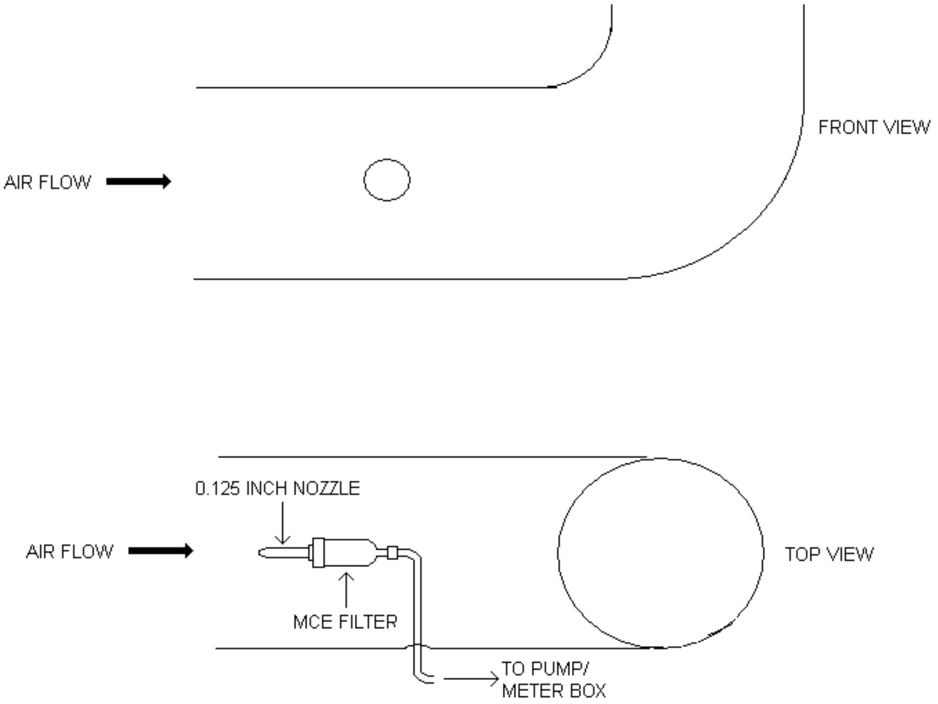

Figure 3-12. OBTF Exit Duct with MCE Filter Sampling Scheme.

Figure 3-13. Stainless Steel Nozzle.

3.15.1.2 Impinger Method

The sampling port for the impingers was in close proximity to the sample port for the MCE filter. The “impinger” sampling method is essentially EPA Method 5[10], with the only variation that no filter is included upstream of the impingers in the sample train.

The sampling train consisted of the probe, followed by four impingers: two each containing 100 mL of deionized (DI) water, one empty, and the last one containing silica gel. The impinger water samples, along with the probe rinse water, were combined and submitted to the laboratory for further preparation (the water samples were sonicated and filtered) and analyzed by TEM by EMSL Analytical, Inc. in Libby, MT[3].

3.15.2 Ash Sampling

After the burn was completed, all the ash remaining from the combustion of the duff was collected, weighed, placed into a glass bottle, and shipped to the analytical laboratory (EMSL Analytical, Inc., in Cinnaminson, NJ) for analysis of LA in the ash as described in Section B4 of the Libby OU3 Burn Chamber QAPP[19].

3.15.3 Burn Hut Wall Wipe Samples

Six wipe samples covering 1 square foot of the floor, ceiling, and each wall of the Burn Hut, were collected after completion of each series of tests under each set of combustion conditions, after the wall-covering aluminum foil had been removed and vacuum cleaning of the Burn Hut interior surfaces was completed. The primary purpose of these samples was to ensure that the Burn Hut was free from residual asbestos contamination so that subsequent entry into the Burn Hut would not subject personnel to asbestos exposure, and to ensure that subsequent experimental efforts in the OBTF could proceed without additional PPE requirements.

3.15.4 Burn Hut Exhaust Gas Volumetric Flow Rate

Flue gas volumetric flow rates were determined by EPA Method 1A: Sample and Velocity Traverses for Stationary Sources with Small Stacks or Ducts[5] and EPA Method 2C: Determination of Stack Gas Velocity and Volumetric Flow Rate in Small Stacks and Ducts (Standard Pitot Tube)[6]. A measurement location in the effluent stream was selected to minimize angular and cyclonic flow. For these tests, traverses were performed 1.52 m (5 ft) downstream of the Burn Hut exhaust duct inlet.

Using Method 1A, the duct cross section was divided into an appropriate number of equal areas and the probe was marked to signify the velocity traverse points. Due to the potential for flow disturbance in small stacks, the sample extraction and flow measurement were performed apart from one another. Sampling ports for extractive samples were located eight equivalent diameters upstream of the velocity sampling ports to allow for the re-establishment of flow stability. Using Method 2C, a traverse for velocity head and sampling duct gas temperature was performed using a standard Pitot tube and TC probe to minimize flow disturbance. Sampling duct gas volumetric flow rate was calculated by use of the resultant data, the sampling duct gas density, and duct cross sectional area. Measurements were performed in conjunction with each test run for filterable/condensable particulate. Flow data, along with pollutant concentration data from concurrent methods was used to calculate pollutant mass emission rates. This determination was made in conjunction with EPA Method 201A[7].

3.15.5 Burn Hut Exhaust Gas Moisture

Sampling duct gas moisture was determined by EPA Method 4: Determination of Moisture Content in Stack Gases[8]. In Method 4, a gas sample is extracted from the source with moisture removed and determined gravimetrically and/or volumetrically. Method 4 samples were taken as a part of the EPA Modified Method 5.

3.15.6 Burn Hut Filterable PM

3.15.6.1 Burn Hut Exhaust $PM_{2.5}$

Filterable $PM_{2.5}$ sampling was performed according to EPA Modified Method 201A:

Determination of PM_{10} and $PM_{2.5}$ Emissions from Stationary Sources (Constant Sampling Rate Procedure) Particulate Emissions from Stationary Sources[7]. An exhaust gas sample was withdrawn from the sampling duct isokinetically and passed through a particle sizer with a nominal diameter of 2.5 µm. A 47-mm Glassmat filter was included in the particle sizing device solely to collect PM with sizes less than or equal to 2.5 µm. The filtered dried gas was measured with a calibrated dry gas meter and the filters were desiccated and weighed according to the EPA Method 201A.

3.15.6.2 Burn Hut Exhaust Total Filterable PM

Burn Hut total filterable PM was measured according to EPA Modified Method 5: Determination of Particulate Matter Emissions from Stationary Sources[10]. PM was withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature of 120 ± 14 °C (248 ± 25 °F). The filtered, dried gas was measured with a calibrated dry gas meter and the filters were desiccated and weighed according to the EPA Method 5.

Both methods were modified slightly due to the small diameter of the sampling duct (10 inches), which is lower than the minimum diameter (16 inches) listed in the method. Due to the small diameter of the sampling duct and the large profile of the $PM_{2.5}$ head, a multi-point velocity traverse was conducted before and after the runs and only single point sampling was performed.

3.15.7 Combustion Temperature

The High and Low Temperature combustion conditions were determined with four K-Type TCs inserted in a radial fashion at the top of the grate. These TCs served to measure the combustion temperature continuously during the burn cycle.

3.15.8 Duff Sample Feed and Burn Rate

For the High Temperature combustion conditions, the duff material was fed by adding two bags (215 g average per bag) at a time at regular intervals (every 5 min). The average duff burning rate over the first sampling hour is about 35 g/min and this rate remained consistent within the burn sequence or between different burn sequences as illustrated in Figure 3-14.

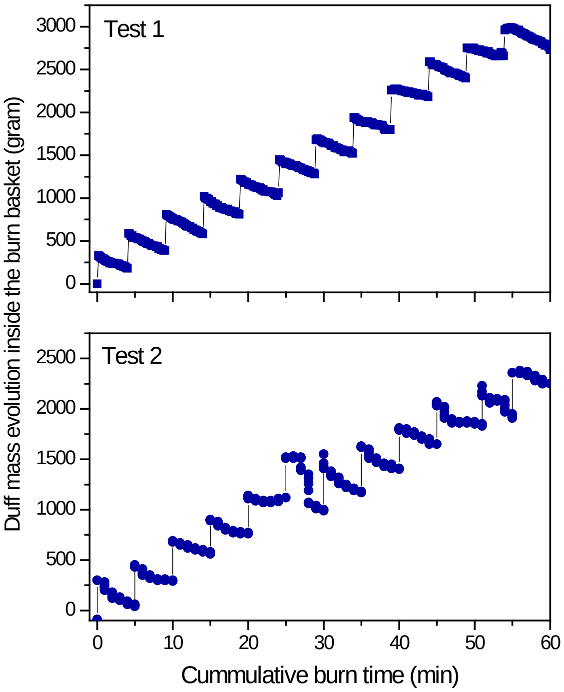

Figure 3-14. Duff Mass Loss during the High Temperature Burn

For the Low Temperature combustion conditions designed to mimic a smoldering burning scenario, the duff material was added one bag (211 g_average per bag over the three burns) at regular intervals (every five min). The average duff burning rate over the first sampling hour for the burns is about 22 g/min and remained consistent with the burn sequence or between different burn sequences as illustrated in Figure 3-15. This burning rate is much lower than the High Temperature setting condition due mostly to the high firing rate of the cast iron propane-fired burner compared to the propane torch and to the halved duff rate required to have sustained combustion during the whole sampling run.

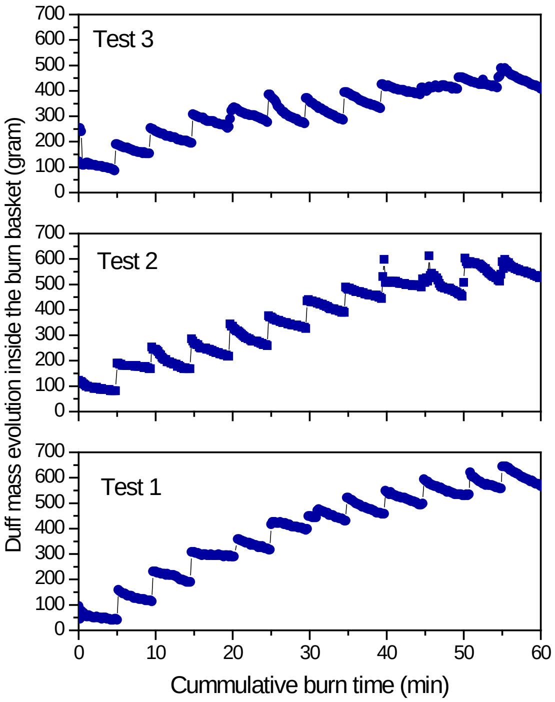

Figure 3-15. Duff Mass Loss during the Low Temperature Burn

3.15.9 Sample Collection Period

3.15.9.1 Extractive Sampling

Sampling started immediately after the feed material was ignited and continued for the whole duration of the test (1 hour).

3.15.9.2 Continuous Measurements

Continuous measurements testing began in general about 30 minutes prior to the onset of the propane fuel burning and continued for another hour after the last extractive sample had been collected. These measurements were not deemed critical but aided in the understanding of the combustion process.

3.15.10 Continuous Emissions Monitors (CEMs)

Continuous instrumental methods were employed via the use of CEMs to measure concentrations of CO_2, O_2, and CO. These instruments were operated in accordance with EPA Method 3A (CO_2/O_2)[12] and EPA Method 10 (CO) as described in 40 CFR Part 60, Appendix A[13].

Burn Hut exhaust gas samples destined for measurement by the CEMs were conditioned to remove water vapor and PM, which are interfering constituents. Components of the sampling system in contact with the sample gas were constructed of Type 316 stainless steel or Teflon® to minimize the possibility of surface chemical reactions, which can affect the accuracy of the measurements. The CO_2/O_2 and CO sample collection and conditioning system consisted of a heated probe and a particulate filter, followed by a moisture-removal trap and an out-of-stack secondary particulate filter. A sample pump (such as Thomas Model 2107CA 18-TFE) transported the effluent sample through a distribution manifold to the analyzers. The configuration of the sampling system allowed the calibration gases to be injected either directly to the analyzers or through the complete sample collection and conditioning system.

The concentration signal outputs from the CEMs were connected to a computer-based data acquisition system (DAS). The DAS used a laptop computer and an analog-to-digital converter. For the purposes of these tests, the data was logged at 6-second intervals without time averaging data. The functioning of the DAS was checked by the EPA Metrology Laboratory to verify that the indicated signal levels were in agreement with calibrated instruments such as digital voltmeters, TC readouts, and other reference measurements.

All pre-test and post-test calibration procedures were performed as outlined in the specific EPA methods.

3.15.10.1 Burn Hut Exhaust Gas CO_2/O_2 (EPA Method 3A)

CO_2 and O_2 concentrations were determined by EPA Method 3A - Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)[12]. In Method 3A, a continuous gas sample is extracted from the stack and conveyed to instrumental analyzers for the determination of O_2 and CO_2 concentration. Results were used in the calculation of sampling duct gas molecular weight.

3.15.10.2 Burn Hut Exhaust Gas CO (EPA Method 10)

CO emissions were determined by EPA Method 10 - Determination of Carbon Monoxide Emissions from Stationary Sources[13]. In Method 10, a continuous gas sample is extracted from the sampling duct and conveyed to an instrumental analyzer (non-dispersive infrared [NDIR] or equivalent) for the determination of CO concentration. Flow data from concurrent EPA Methods 1A[5] and 2C[6] were used to calculate CO mass emission rates.

3.16 Analytical Methods

3.16.1 LA Analysis

All MCE filters, collected water samples from impinger sampling, and ash material generated by burning duff material in the Burn Hut were shipped to the analytical laboratory (EMSL Analytical, Inc.) for estimation of the LA in each sample by TEM, as per Section B.4 of the OU3 Burn Chamber SAP[19]. Sample packaging and shipping of air filters for the analysis of LA followed the requirements described in OU3 SOP No. 8, Revision 1[24].

3.16.2 $PM_{2.5}$ in Exhaust Flue Smoke

The mass of $PM_{2.5}$ material emitted in smoke during the burn was measured by Resolution Analytics, Inc. (Sanford< North Carolina) gravimetrically in general accord with the approach described in EPA Method 201A – Determination of PM_{10} and $PM_{2.5}$ Emissions from Stationary Sources (Constant Sampling Rate Procedure)[7].

4.0 RESULTS AND DISCUSSION

A summary of the sampling information including sampling times, volumes, isokinetic rates and sample mass collected can be found in Table 4-1 (High Temperature), Table 4-2 (Low Temperature), and Table 4-3 (Blanks). The average temperatures, CO_2, and CO can be found in Table 4-4 (High Temperature), Table 4-5 (Low Temperature), and Table 4-6 (Blanks). The results from the carbon balance calculations are shown in Table 4-7 (High Temperature) and Table 4-8 (Low Temperature). During Test 2, the low range CO_2 analyzer did not work, and the results from that test are reported solely based on the high range CO_2 analyzer. It is not known why the CO_2 from the second test is so low compared to Test 1 and Test 3.

Delta CO_2 is used to determine the mass of carbon burned in each phase (pre-duff burning, duff burning). For the pre-burning (burner only), ambient CO_2 was subtracted from CO_2 generated from the burner. The Delta CO_2 for the duff burning is the emissions of CO_2 minus the CO_2 generated during the pre-duff burning. For most of the experiments, the ambient CO_2 is about 400 ppmv, and the CO_2 emitted from the burner is about 1600 ppmv.

The combustion efficiencies for the duff burns, defined as the molar emissions of CO_2 divided by the molar emissions of CO + CO_2 are 94.9 % with a standard deviation of 2.3% for the High Temperature burns and 94.6 % with a standard deviation of 3.8% for the Low Temperature burns.

Table 4-1. Sampling Information from High Temperature Test Conditions.

Test ID[1]	Sampling Train Type	Start Time	End Time	Sample Volume (Dry Std. Liters)	Total Flue Gas Volume (Dry Std. Liters)	Isokineticity (%)	Sample Mass (g)
Air sampling		**10:00**	**10:15**				
Pre-Duff sampling (Burner Only)		14:15	14:40				
EX-HT-IMP-01-121911	Impinger Sampling Method for Asbestos	14:40	15:40	1192.2	2064330	97	1429
EX-HT-PM-01-121911	Total PM Sampling Using EPA Method 5	14:40	15:40	1229.6	2053359	101	1474
EX-HT-PM2.5-01-121911	PM 2.5 Sampling Using EPA 201a	14:40	15:40	751.2	2069390	95	900
EX-HT-MCE-01A-121911	Asbestos Sampling Using SOP-2015	14:40	14:15	76.6	515590	Non-Isokinetic Sampling	92
EX-HT-MCE-01B-121911		14:56	15:11	75.6			91
EX-HT-MCE-01C-121911		15:12	15:27	73.6			88
EX-HT-MCE-01D-121911		15:28	15:43	75.6			91
Air sampling		**9:13**	**9:28**				
Pre-Duff sampling		10:52	11:01				
EX-HT-IMP-02-122211	Impinger Sampling Method for Asbestos	11:05	12:05	1126.9	1825560	106	1351
EX-HT-PM-02-122211	Total PM Sampling Using EPA Method 5	11:05	12:05	1110.1	1831670	102	1331
EX-HT-PM2.5-02-122211	PM 2.5 Sampling Using EPA 201a	11:05	12:05	753.2	1828452	108	903
EX-HT-MCE-02A-122211	Asbestos Sampling Using SOP-2015	11:05	11:20	74.9	457140	Non-Isokinetic Sampling	90
EX-HT-MCE-02B-122211		11:21	11:36	78.9			95
EX-HT-MCE-02C-122211		11:37	11:52	76.0			91
EX-HT-MCE-02D-122211		11:53	12:08	82.6			99
Air sampling		**8:49**	**9:15**				
Pre-Duff sampling		10:09	10:14				
EX-HT-IMP-03-122811	Impinger Sampling Method for Asbestos	10:16	11:16	1038.5	1858606	99	1245
EX-HT-PM-03-122811	Total PM Sampling Using EPA Method 5	10:16	11:16	1119.8	1876974	100	1342
EX-HT-PM2.5-03-122811	PM 2.5 Sampling Using EPA 201a	10:16	11:16	769.4	1861996	109	922
EX-HT-MCE-03A-122811	Asbestos Sampling Using SOP-2015	10:16	10:31	48.4	466465	Non-Isokinetic Sampling	58
EX-HT-MCE-03B-122811		10:34	10:49	75.6			91
EX-HT-MCE-03C-122811		10:50	11:05	78.7			94
EX-HT-MCE-03D-122811		11:06	11:21	70.8			85

[1] Sample ID descriptor: AA-BB-CCC -NN-MMDDYY (where AA defines the sampling location; BB the combustion temperature setting; CCC, the type of sampling train; NN, the run number; MMDDYY, month, day, and year when the test was run).

Table 4-2. Sampling Information from Low Temperature Test Conditions.

Test ID	**Sampling train Type**	**Start Time**	**End Time**	**Sample Volume (Dry Std. Liters)**	**Total Flue gas Volume (Dry Std. Liters)**	**Isokinetic rate (%)**	**Sample Mass (g)**
Ambient air		**10:55**	**11:05**				
Pre-Duff sampling (Torch Only)	Impinger Sampling Method for Asbestos	11:05	12:05	1187.5	2134181	97	1423
EX-LT-IMP-02-021412	Total PM Sampling Using EPA Method 5	11:05	12:05	1187.4	2136481	99	1423
EX-LT-PM-03-021412	PM 2.5 Sampling Using EPA 201a	11:05	12:05	745.0	2127280	92	898
EX-LT-PM2.5-03-021412	Asbestos Sampling Using SOP-2015	11:05	11:20	139.6	541173	106	167
EX-LT-MCE-03A-021412		11:21	11:36	127.8	533773	98	153
EX-LT-MCE-03B-021412		11:37	11:52	127.4	530347	98	152
EX-LT-MCE-03C-021412		11:54	12:09	126.1	528099	98	151
Ambient air		**9:01**	**9:03**				
Pre-Duff sampling (Torch Only)		10:50	11:10				
EX-LT-IMP-03-021512	Impinger Sampling Method for Asbestos	11:10	12:10	1189.0	2094171	99	1425
EX-LT-PM-03-021512	Total PM Sampling Using EPA Method 5	11:10	12:10	1167.3	2100541	99	1399
EX-LT-PM2.5-03-021512	PM 2.5 Sampling Using EPA 201a	11:10	12:10	753.7	2091134	95	909
EX-LT-MCE-03A-021512	Asbestos Sampling Using SOP-2015	11:10	11:25	105.5	34377	81	126
EX-LT-MCE-03B-021512		11:28	11:43	132.0	43258	102	158
EX-LT-MCE-03C-021512		11:42	11:57	127.8	42227	99	153
EX-LT-MCE-03D-021512		11:58	12:13	127.7	42454	100	153
EX-LT-MCE-02E-021512		12:15	12:30	131.1	42339	100	157
Ambient air		**8:05**	**8:20**				
Pre-Duff sampling (Torch Only)		9:36	9:40				
EX-LT-IMP-03-021612	Impinger Sampling Method for Asbestos	9:40	10:40	1136.9	2042326	97	1363
EX-LT-PM-03-021612	Total PM Sampling Using EPA Method 5	9:40	10:40	1142.8	2047923	99	1370
EX-LT-PM2.5-03-021612	PM 2.5 Sampling Using EPA 201a	9:40	10:40	747.9	2041983	96	902
EX-LT-MCE-03A-021612	Asbestos Sampling Using SOP-2015	9:40	9:55	127.0	518852	100	152
EX-LT-MCE-03B-021612		9:56	10:11	134.4	515172	107	161
EX-LT-MCE-03C-021612		10:13	10:28	124.3	513596	99	149
EX-LT-MCE-03D-021612		10:29	10:44	132.6	513650	106	159
EX-LT-MCE-03E-021612		10:46	11:01	131.1	523940	103	157

Table 4-3. Sampling Information from Blanks.

Test ID	Type of Blank Sample	Sampling train Type	Start Time	End Time	Sample Volume	Total Flue gas Volume	Isokineticity	Sample Mass
			EDT		Dry Standard Liters		%	Grams
EX-PM Hot Blank-01-121511 (burner ON)	Burner ON	Impinger sampling Method for Asbestos	13:48	14:48	1814.6	1863854	100	2177
EX-Hot blank-PM-01-121511		Total PM sampling using EPA Method 5	13:48	14:48	1816.9	1838951	101	2178
EX-Hot Blank-PM2.5-01-121511		PM 2.5 Sampling using EPA 201a	13:48	14:48	777.0	1860732	110	931
EX-Hot blank-MCE-01B-121511		Asbestos Sampling using SOP-2015	13:55	14:55	156.5	1854512	Non-Isokinetic sampling	188
EX-PM Air Blank-01-122911	Ambient air inside the Burn Hut	Impinger sampling Method for Asbestos	11:15	12:15	1061.0	1854875	101	1272
EX-HT-PM-01-122911		Total PM sampling using EPA Method 5	11:15	12:15	1110.4	1856470	101	1331
EX-HT-PM2.5-01-122911		PM 2.5 Sampling using EPA 201a	11:15	12:15	756.4	1854018	115	907
EX-HT-MCE-01B-122911		Asbestos Sampling using SOP-2015	11:15	12:15	317.0	1855121	Non-Isokinetic sampling	380
EX-IMP LT Blank-01-021712	Torch ON	Impinger sampling Method for Asbestos	9:45	10:45	1170.9	2042686	100	1404
EX-PM LT Blank-01-021712		Total PM sampling using EPA Method 5	9:45	10:45	1149.9	2038362	100	1379
EX-PM2.5 LT Blank-01-021712		PM 2.5 Sampling using EPA 201a	9:45	10:45	750.4	2045959	96	895
EX-MCE LT Blank-01-021712		Asbestos Sampling using SOP-2015	9:45	10:45	508.2	2063102	101	606

Table 4-4. Average Temperatures, CO_2, and CO for High Temperature Test Conditions.

Test ID	**Temperature at the Grate (°C)**				**Temperature 4 inches Above the Grate (°C)**		**Average CO_2**	**Average CO**	**Delta CO_2**	**Delta CO**
	T1	**T2**	**T3**	**T5**	**T4**	**T6**	**ppmv**			
Air Sampling	**8**	**8**	**5**	**8**	**8**	**8**	**644**	**6**	**NA[1]**	
Pre-Duff Sampling (Burner Only)	712	791	919	562	562	493	1852	7.50	1208	1
EX-HT-IMP-01-121911	878	810	829	717	717	556	3717	75	1865	68
EX-HT-PM-01-121911	878	810	829	717	717	556	3717	75	1865	68
EX-HT-PM2.5-01-121911	878	810	829	717	717	556	3717	75	1865	68
EX-HT-MCE-01A-121911	899	858	852	684	684	578	3309	37	1457	30
EX-HT-MCE-01B-121911	888	799	826	734	734	582	3648	70	1796	62
EX-HT-MCE-01C-121911	846	782	820	718	718	592	3868	96	2016	88
EX-HT-MCE-01D-121911	884	804	819	738	738	430	4074	95	2222	88
Air Sampling	**15**	**15**	**17**	**16**	**16**	**16**			NA	
Pre-Duff Sampling (Burner Only)	785	746	772	572	393	496	1713	0	Nav[2]	
EX-HT-IMP-02-122211	857	907	746	753	476	527	2381	58	667	57
EX-HT-PM-02-122211	857	907	746	753	476	527	2381	58	667	57
EX-HT-PM2.5-02-122211	857	907	746	753	476	527	2381	58	667	57
EX-HT-MCE-02A-122211	845	931	700	726	542	560	2145	21	431	21
EX-HT-MCE-02B-122211	839	909	759	755	418	506	2328	46	615	46
EX-HT-MCE-02C-122211	858	901	763	764	449	520	2424	74	710	74
EX-HT-MCE-02D-122211	890	877	761	769	519	531	2692	98	979	98
Air Sampling	**5**	**5**	**5**	**6**	**6**	**6**			NA	
Pre-Duff Sampling (Burner Only)	659	756	939	804	546	484	1342	0	NAv	
EX-HT-IMP-03-122811	888	832	936	776	582	596	2674	61	1332	61
EX-HT-PM-03-122811	888	832	936	776	582	596	2674	61	1332	61
EX-HT-PM2.5-03-122811	888	832	936	776	582	596	2674	61	1332	61
EX-HT-MCE-03A-122811	955	851	974	818	606	615	2237	11	895	11
EX-HT-MCE-03B-122811	934	840	929	757	565	593	2548	41	1207	41
EX-HT-MCE-03C-122811	846	833	953	768	578	588	2844	86	1502	86
EX-HT-MCE-03D-122811	763	781	846	753	597	603	3236	127	1894	128

[1] Not applicable; [2] Not available

Table 4-5. Average Temperatures, CO_2, and CO for Low Temperature Test Conditions.

Test ID	Temperature at the Grate (°C)						Duct Temperature (°C)	Average CO_2	Average CO	Delta CO_2	Delta CO
	T1	T2	T3	T4	T5	T6		ppmv			
Ambient Air	**9**		**9**	**9**	**9**	**9**	**9**	**426**	**10**	NA	
Pre-Duff Sampling (Torch Only)										NAv	
EX-LT-IMP-02-021412	388	NA	323	298	395	364	22	604	28	The torch emissions were not available to determine the mass of carbon burned from duff only	
EX-LT-PM-03-021412	388		323	298	395	364		604	28		
EX-LT-PM2.5-03-021412	388		323	298	395	364		604	28		
EX-LT-MCE-03A-021412	216		229	135	132	135	25	708	24		
EX-LT-MCE-03B-021412	450		378	359	488	446	23	608	36		
EX-LT-MCE-03C-021412	441		351	349	480	440	21	569	28		
EX-LT-MCE-03D-021412	442		320	343	471	431	20	416	17		
Ambient Air	**6**	**NA**	**7**	**7**	**7**	**7**	**9**	**454**	**12**	NA	
Pre-Duff Sampling (Torch Only)	127		135	118	101	128	33	916	0		
EX-LT-IMP-03-021512	225		340	283	203	205	46	1542	41	626	41
EX-LT-PM-03-021512	225		340	283	203	205	46	1542	41	626	41
EX-LT-PM2.5-03-021512	225		340	283	203	205	46	1542	41	626	41
EX-LT-MCE-03A-021512	74		106	199	55	77	38	1055	2	139	2
EX-LT-MCE-03B-021512	105		323	260	81	98	44	1349	28	433	28
EX-LT-MCE-03C-021512	330		506	331	320	307	50	1854	66	939	66
EX-LT-MCE-03D-021512	449		493	371	423	398	52	2103	83	1187	83
EX-LT-MCE-02E-021512	443		436	387	476	446	28	869	68	415	55
Ambient Air	**8**	**Na**	**8**	**8**	**8**	**8**	**8**	**466**	**0**	NA	
Pre-Duff Sampling (Torch Only)	127		143	158	107	139	24	629	0	NAv	
EX-LT-IMP-03-021612	306		486	488	236	251	33	818	0	189	0
EX-LT-PM-03-021612	306		486	488	236	251	33	818	0	189	0
EX-LT-PM2.5-03-021612	306		486	488	236	251	33	818	0	189	0
EX-LT-MCE-03A-021612	143		408	312	61	99	28	681	3	52	2
EX-LT-MCE-03B-021612	336		545	613	228	269	31	799	14	170	14
EX-LT-MCE-03C-021612	366		487	511	325	311	35	927	22	298	21
EX-LT-MCE-03D-021612	392		497	508	354	341	37	857	32	228	32
EX-LT-MCE-03E-021612	396		505	542	431	381	19	530	19	64	19

Table 4-6. Average Temperatures, CO_2, and CO for Blanks.

Test ID	Temperature at the grate				Temperature 4 inches above the grate		Average CO2	Average CO	Delta CO2	Delta CO	CO2 generated from the burner	CO generated from the burner	Mass of Carbon generated from the burner	
	T1	T2	T3	T5	T4	T6	ppmv				ppmm		sampled	Total
Ambient air	16	19	17	17	19	17	437	0.00	NA					
EX-PM Hot Blank-01-121511 (burner ON)	830	748	826	144	120	672	1845	0	1408	0	2147	0.0	1.27	1309
EX-Hot blank-PM-01-121511	830	748	826	144	120	672	1845	0	1408	0	2147	0.0	1.28	1291
EX-Hot Blank-PM2.5-01-121511	830	748	826	144	120	672	1845	0	1408	0	2149	0.0	0.55	1307
EX-Hot blank-MCE-01B-121511	830	748	826	144	120	672	1845	0	1408	0	2148	0.0	0.11	1302
Ambient air	NAv						437	0			NA			
EX-IMP LT Blank-01-021712	153	117	437	191	116	117	732	0	295	0	450	0.0	0.17	301
EX-PM LT Blank-01-021712	153	117	437	191	116	117	732	0	295	0	450	0.0	0.17	300
EX-PM2.5 LT Blank-01-021712	153	117	437	191	116	117	733	0	296	0	453	0.0	0.11	302
EX-MCE LT Blank-01-021712	153	117	437	191	116	117	733	0	296	0	451	0.0	0.07	303

Table 4-7. Carbon Balance from High Temperature Test Conditions.

Test ID	CO_2 Generated from the Burn	CO Generated from the Burn	Mass of Carbon Generated from the Burner or Duff (g)		Mass of Duff Inserted (g)	Mass of Ash Remaining (g)	Mass Loss Using the Scale (g)
	ppmm		Sampled	Total	Total	After 24 hours Smoldering	During Testing
Pre-Duff Sampling (Burner Only)	1843	1.2	0.00				
EX-HT-IMP-01-121911	2845	65.8	1.15	1990	5081	2379	NAv
EX-HT-PM-01-121911	2845	65.8	1.19	1760			
EX-HT-PM2.5-01-121911	2845	65.8	0.72	1792			
EX-HT-MCE-01A-121911	2223	28.9	0.057	355			
EX-HT-MCE-01B-121911	2740	60.4	0.070	444			
EX-HT-MCE-01C-121911	3076	85.9	0.077	503			
EX-HT-MCE-01D-121911	3390	85.2	0.087	552			
Pre-Duff Sampling (Burner Only)							
EX-HT-IMP-02-122211	1018	55.8	0.41	660	5123	2397	2030
EX-HT-PM-02-122211	1018	55.8	0.40	662			
EX-HT-PM2.5-02-122211	1018	55.8	0.27	661			
EX-HT-MCE-02A-122211	656	20.3	0.017	103			
EX-HT-MCE-02B-122211	938	44.8	0.026	151			
EX-HT-MCE-02C-122211	1084	71.6	0.030	179			
EX-HT-MCE-02D-122211	1493	95.0	0.044	246			
Pre-Duff sampling (Burner Only)							
EX-HT-IMP-03-122811	2033	59.2	0.72	1292	5255	2329	2300
EX-HT-PM-03-122811	2033	59.2	0.78	1305			
EX-HT-PM2.5-03-122811	2033	59.2	0.53	1294			
EX-HT-MCE-03A-122811	1366	10.7	0.022	211			
EX-HT-MCE-03B-122811	1841	39.8	0.047	290			
EX-HT-MCE-03C-122811	2293	84.0	0.062	370			
EX-HT-MCE-03D-122811	2890	124.0	0.071	470			

Table 4-8. Carbon Balance from Low Temperature Test Conditions.

Test ID	CO_2 Generated from Duff	CO Generated from Duff	Mass of Carbon Generated from Duff (g)	Mass of Duff Inserted (g)		Mass of Ash Remaining (g)	Mass Loss Using the Scale (g)
	ppmm		Sampled	Total	Total	After 24 Hours Smoldering	During Testing
EX-LT-IMP-02-021412	No CEM Data				2542	1090	1210
EX-LT-PM-03-021412							
EX-LT-PM2.5-03-021412					636		310
EX-LT-MCE-03A-021412					845		170
EX-LT-MCE-03B-021412					641		290
EX-LT-MCE-03C-021412					630		440
EX-LT-IMP-03-021512	956	39.8	0.40	697	2485	917	1290
EX-LT-PM-03-021512	956	39.8	0.39	699			
EX-LT-PM2.5-03-021512	950	39.6	0.25	696			
EX-LT-MCE-03A-021512	212	2.0	0.01	2	641		290
EX-LT-MCE-03B-021512	661	27.5	0.03	10	630		390
EX-LT-MCE-03C-021512	1433	64.5	0.06	21	629		420
EX-LT-MCE-03D-021512	1811	80.8	0.08	27	585		190
EX-LT-MCE-02E-021512	633	53.9	0.03	10	0		210
EX-LT-IMP-03-021612	289	16.2	0.12	210	2568	1184	1420
EX-LT-PM-03-021612	289	16.2	0.12	211			
EX-LT-PM2.5-03-021612	287	16.1	0.08	210			
EX-LT-MCE-03A-021612	79	2.3	0.003	14	640		330
EX-LT-MCE-03B-021612	259	13.3	0.012	47	643		450
EX-LT-MCE-03C-021612	455	20.9	0.020	83	641		50
EX-LT-MCE-03D-021612	348	30.7	0.017	67	644		590
EX-LT-MCE-03E-021612	98	18.5	0.005	21	0		0

4.1 Burn Hut Operational Parameters and PM Results

Table 4-9 lists the test conditions and PM results for the three High Temperature burns and Table 4-10 lists the test conditions and PM emissions for the three Low Temperature burns. Although the $PM_{2.5}$ average bulk concentrations were similar for both the High Temperature and Low Temperature test conditions, when normalized based on the amount of duff fed in the experiment, the $PM_{2.5}$ emissions for the High Temperature burns was roughly half that of the Low Temperature burns. Note that the variability of $PM_{2.5}$ emissions was higher for the High Temperature tests (ranging from 6.1 to 12.0 g $PM_{2.5}$ per kg of duff burned) than they were for the Low Temperature tests (ranging from 16.1 to 18.3 g $PM_{2.5}$ per kg of duff burned). There is not an obvious reason for this difference in variability, although fluid mechanics related to the Burn Chamber might possibly be the cause. At any rate, a factor-of-two difference between the highest and lowest value for an emission factor is not an unreasonably high amount of variability for small-scale, batch, transient experiments. These emission factors compare favorably with the EPA published emission factors from the AP-42 emission factor database[25] for prescribed burning, which vary from 4 to 16 g $PM_{2.5}$ per kg of biomass combusted. Total Filterable PM including the condensable fraction presented in Table 4-9 and 4-10 were sampled using EPA Method 201A, while total filterable PM were sampled using EPA Method 5.

Table 4-9. Burn Parameters and PM Results for High Temperature Burn Conditions.

Parameter	**Units**	**Burn 1**	**Burn 2**	**Burn 3**
Date of burn	--	12/19/2012	12/22/2012	12/28/2012
Mass of duff fed	g (wet wt)	5081	5123	5255
	g (dry wt)	4624	4662	4782
Mass of ash collected	g	2379	2397	2329
Flow rate through hut	m^3/min	34.4	30.4	31
Sample duration	min	60	60	60
Total volume through hut	L	2.06E+06	1.83E+06	1.86E+06
Concentration of $PM_{2.5}$	mg/m^3	26.89	21.64	15.59
$PM_{2.5}$ Emissions	g/kg $duff_{fed}$	12	8.5	6.1
Concentration of Total PM[1] including Condensable	mg/m^3	31.81	29.21	23.26
Total PM Emissions including condensable	g/kg $duff_{fed}$	14.2	11.5	9.0
Concentration of Total[2] Filterable PM	mg/m^3	19.9	9.28	11.8
Total Filterable PM Emissions	g/kg $duff_{fed}$	8.9	3.6	4.6

[1] per EPA Method 201A; [2] per to Method 5

Table 4-10. Burn Parameters and PM Results for Low Temperature Burn Conditions.

Parameter	Units	Burn 1	Burn 2	Burn 3
Date of burn	--	2/14/2012	2/15/2012	2/16/2012
Mass of duff fed	g (wet wt)	2542	2485	2568
	g (dry wt)	2313	2261	2337
Mass of ash collected	g	1090	917	1184
Flow rate through hut	m^3/min	35.6	34.9	34
Sample duration	min	60	60	60
Total volume through hut	L	2.13E+06	2.09E+06	2.04E+06
Concentration of $PM_{2.5}$	mg/m^3	17.45	19.77	20.72
$PM_{2.5}$ Emissions	g/kg $duff_{fed}$	16.1	18.3	18.1
Concentration of Total Filterable PM including Condensable[1]	mg/m^3	22.55	23.75	23.4
Total PM Emissions including Condensable	g/kg $duff_{fed}$	20.8	22.0	20.4
Concentration of Total Filterable PM[2]	mg/m^3	5.81	9.42	10.2
Total Filterable PM Emissions	g/kg $duff_{fed}$	5.4	8.7	8.9

[1]per EPA Method 201A; [2] per to Method 5

4.2 Asbestos Results

Total LA fibers in the flue gas were calculated using Equation (1):

$$N_{flue} = N * S * V_t \qquad (1)$$

where N_{flue} is the number of structures in the flue gas, N is the total number of structures, S is the analytical sensitivity (cc^{-1}), and V_t is the total volume of air sampled.

The analytical sensitivity is computed using Equation (2) (this equation is in ISO 10312, Section 8, Note 6)[3]:

$$S = EFA / (GO_x * Ago * V * 1000 * F) \qquad (2)$$

Where EFA is the effective filter area (mm^2), GO_x is the number of grid openings examined, Ago is the area of a grid opening (mm^2), V is the volume of air sampled (L), 1000 is the conversion factor (L to cc), F, the “F-Factor” is the indirect preparation dilution factor. The Sampling and Analysis Plan for OU3[11] describes the counting rules to meet necessary sensitivity requirements for LA fibers.

4.2.1 MCE Filter Samples

Table 4-11 lists the MCE filter results for the High Temperature burn conditions and Table 4-12 lists the MCE filter results for the Low Temperature burn conditions. After the results from the High Temperature tests were analyzed, and the MCE filters were not detecting LA fibers on all runs, the filter cartridge was turned into the flow for the Low Temperature runs. This procedure still did not result in significant fibers being found on the MCE filters. Based on MCE filter data, only a small fraction of the LA fibers initially in the duff were found in the combustion emissions. The poor performance of fiber collection on the MCE filters when placed either tangential to the flow or isokinetically is not explainable at this point. Neither sampling configuration worked well or was reproducible. It may be that filter cassettes are not suitable for particle collection in a combustion system due to the characteristics of the flue gas. It may be that the MCE filter material warped or changed its collection efficiency at the temperatures and water vapor concentrations in the flue gas. There was no evidence that the filter buckled in the cassette. Because of these sampling issues, the impinger results were used rather than the MCE filter results.

Table 4-11. MCE Filter Results for High Temperature Burn Conditions.

Burn	**Burn**	**Burn**	**Sample**	**Volume**	**Sensitivity**	**Count**		**Conc (f/cc)**		**Volume through the hut**	**Percent Released**	
Trial	**Date**	**Temp**	**ID**	**L**	**S (cc^{-1})**	**Total**	**PCME**	**Total**	**PCME**	**cc**	**Total**	**PCME**
1	12/19/11	High	A	76.56	0.145	0	0	0.000	0.000	4.62E+08	0.00%	0.00%
			B	75.64	0.146	0	0	0.000	0.000		0.00%	0.00%
			C	73.63	0.150	0	0	0.000	0.000		0.00%	0.00%
			D	75.55	0.147	0	0	0.000	0.000		0.00%	0.00%
			Mean	75.35	0.147	0	0	0.000	0.000		0.00%	0.00%
2	12/22/11	High	A	74.87	0.074	0	0	0.000	0.000	4.61E+08	0.00%	0.00%
			B	78.92	0.070	0	0	0.000	0.000		0.00%	0.00%
			C	75.95	0.073	0	0	0.000	0.000		0.00%	0.00%
			D	82.62	0.067	0	0	0.000	0.000		0.00%	0.00%
			Mean	78.09	0.071	0	0	0.000	0.000		0.00%	0.00%
3	12/28/11	High	A	48.44	0.057	0	0	0.000	0.000	4.66E+08	0.00%	0.00%
			B	75.58	0.037	0	0	0.000	0.000		0.00%	0.00%
			C	78.72	0.035	10	3	0.352	0.106		0.003%	0.006%
			D	70.76	0.039	23	4	0.900	0.157		0.009%	0.009%
			Mean	68.38	0.042	8.25	1.75	0.313	0.066		0.003%	0.004%

Table 4-12. MCE Filter Results for Low Temperature Burn Conditions.

Burn	Burn	Burn	Sample	Volume	GO	Sensitivity	Count		Conc (f/cc)		Volume	Percent Released	
Trial	**Date**	**Temp**	**ID**	**L**	**Counted**	**S (cc^{-1})**	**Total**	**PCME**	**Total**	**PCME**	**cc**	**Total**	**PCME**
1	2/14/2012	Low	A	139.6	4.0	0.055	1	0	0.055	0.000	5.41E+08	0.01%	0.00%
			B	127.8	4.0	0.060	0	0	0.000	0.000	5.34E+08	0.00%	0.00%
			C	127.4	4.0	0.060	0	0	0.000	0.000	5.30E+08	0.00%	0.00%
			D	126.1	4.0	0.061	0	0	0.000	0.000	5.28E+08	0.00%	0.00%
			Mean (A-D)	130.3	4.0	0.059	0.25	0	0.014	0.000	5.33E+08	0.00%	0.00%
2*	2/14/2012	Low	A	105.5	4	0.073	0	0	0.000	0.000	3.44E+07	0.00%	0.00%
			B	132.0	4	0.058	8	3	0.466	0.175	4.33E+07	0.09%	0.19%
			C	127.8	4	0.060	0	0	0.000	0.000	4.22E+07	0.00%	0.00%
			D	127.7	4	0.060	3	0	0.181	0.000	4.25E+07	0.02%	0.00%
			E	131.1	4	0.059	0	0	0.000	0.000	4.23E+07	0.00%	0.00%
			Mean (B-E)	129.6	4	0.059	2.75	0.75	0.162	0.044	4.26E+07	0.03%	0.05%
3	2/16/2012	Low	A	127.0	4	0.061	0	0	0.000	0.000	5.19E+08	0.00%	0.00%
			B	134.4	4	0.057	0	0	0.000	0.000	5.15E+08	0.00%	0.00%
			C	124.3	4	0.062	0	0	0.000	0.000	5.14E+08	0.00%	0.00%
			D	132.6	4	0.058	1	0	0.058	0.000	5.14E+08	0.13%	0.00%
			E	131.1	4	0.059	0	0	0.000	0.000	5.24E+08	0.00%	0.00%
			Mean (A-D)	129.9	4	0.0594	0.2	0	0.015	0.000	5.17E+08	0.032%	0.000%

* MCE filter A cracked

4.2.2 Impinger Samples

Table 4-13 lists the asbestos data from the impinger samples from the High Temperature burn conditions, and Table 4-14 lists the asbestos data from the impinger samples from the Low Temperature burn data. Although the number of LA fibers per cc seen from the impinger samples was greater than from the MCE filter samples, the fraction of the LA initially found in the duff that was measured in the combustion gas exhaust emissions was only a fraction of a percent. This observation suggests that significant numbers of LA fibers are not released from the duff through either the flaming combustion regime or the smoldering combustion regime. The results from the LA fibers in the residual ash must be examined to assess the overall mass balance of asbestos from duff combustion. Since the results from the MCE filters were below the detection limit, quantitation was not possible. (Note that the sampling flow for the MCE filter is about 6% of the sampling flow for the impingers). Possibly the elevated temperatures in the duct distorted or affected flow rate through the MCE filters. Because of this, the impinger results were used for all emission factor calculations.

Table 4-13. Impinger Results for High Temperature Burn Conditions.

Parameter	**Units**	**Run 1**	**Run 2**	**Run 3**
Date	--	12/19/11	12/22/11	12/28/11
Volume of air through impinger	L	1192.2	1126.9	1038.5
F factor	--	0.10	0.02	0.02
GOs	--	4	21	6
Ago	mm^2	0.013	0.013	0.013
EFA	mm^2	360	360	360
S	$(cc\ air)^{-1}$	0.058	0.059	0.222
N (total LA)	f	176	52	51
N (PCME LA)	f	36	10	11
Ratio (PCME / total)		20%	19%	22%
Concentration in flue gas	total f/cc	10.2	3.04	11.3
	PCME f/cc	2.09	0.59	2.44
Total Volume	cc	2.06+09	1.83E+09	1.86E+09
Total fibers in flue gas over test duration (number)	Total LA	2.11+10	5.55+09	2.11+10
	PCME LA	4.32+09	1.07E+09	4.54+09
Total Fibers in the original duff over test duration (number)	Total LA	4.18E+12	4.21E+12	4.32E+12
	PCME LA	7.35E+11	7.41E+11	7.60E+11
Fractional release from duff	% total	0.50%	0.13%	0.49%
	% PCME	0.59%	0.14%	0.60%

Table 4-14. Impinger Results for Low Temperature Burn Conditions.

Parameter	**Units**	**Run 1**	**Run 2**	**Run 3**
Date	--	02/14/12	02/15/12	02/16/12
Volume of air through impinger	L	1187	1189.0	1136.9
F factor	--	0.9	0.9	0.90
GOs	--	6	4	5
Ago	mm^2	0.013	0.013	0.013
EFA	mm^2	1295	1295	1295
S	(cc air)$^{-1}$	0.016	0.023	0.019
N (total LA)	f	50	51	53
N (PCME LA)	f	7	7	11
Ratio (PCME / total)		14%	14%	21%
Concentration in flue gas	total f/cc	0.78	1.19	1.03
	PCME f/cc	0.11	0.16	0.21
Total Volume	cc	2.13E+09	2.09E+09	2.04E+09
Total fibers in flue gas over test duration (number)	Total LA	1.66E+09	2.49E+09	2.11E+09
	PCME LA	2.32E+08	3.41E+08	4.37E+08
Total Fibers in the original duff over test duration(number)	Total LA	2.09E+12	2.04 E+12	2.11E+12
	PCME LA	3.68E+11	3.59E+11	3.72E+11
Fractional release from duff	% total	0.08%	0.12%	0.10%
	% PCME	0.06%	0.09%	0.12%

4.2.3 Ash Samples

Table 4-15 lists the results from analyzing the residual ash from the High Temperature burn conditions for LA fibers, and Table 4-16 lists the results from analyzing the residual ash from the Low Temperature burn conditions for LA fibers. These results are qualitatively consistent with the combustion emissions results. A significant fraction of the initial LA fibers found in the duff remain behind in the residual ash for both the High Temperature and Low Temperature burn conditions. The High Temperature burn conditions showed total LA structures in the residual ash ranging from 41 to 100 % of the total initial LA fibers, and, when based on PCME structures, approximately 84 to 105% remained behind in the residual ash. For the Low Temperature test conditions, 48 to 53 % of the total LA fibers and 88 to 115% based on PCME structures remained behind in the residual ash. These results are more consistent than the ashing results presented in Table 3-4 where the total LA structures in the residual ash ranged from 162 to 177 % of the total initial LA fibers, and similarly when based on PCME structures and 159 to 177% remained in the ash. These numbers seem to be erroneous because no fiber is produced during the ashing process but may be due to experimental problems. It might be interesting to look at the fiber size distribution in these samples. It could be that the longer fibers get broken during heating, yielding more of the shorter fibers.

Table 4-17 lists the results from a proximate and ultimate analysis of the residual ash. This analysis showed that the residual ash still contained approximately 2 % carbon. These results will be used in Section 4.5 for the carbon balance calculations.

Table 4-15. Residual Ash Results from High Temperature Burn Conditions.

Parameter	**Units**	**Results**		
Sample	--	1	2	3
Burn date	--	12/19/11	12/22/11	12/28/11
Mass suspended	g	0.25	0.25	0.25
Suspension volume	mL	100	100	100
Vol filtered	mL	0.1	0.3	0.5
F Factor	--	0.001	0.003	0.005
GO	--	12	4	6
Ago	mm^2	0.0132	0.0132	0.0132
EFA	mm^2	1290	1290	1290
S	$(g\ ash)^{-1}$	3.26E+07	3.26E+07	1.30E+07
Counts	total LA structures	54	54	58
	PCME structures	10	8	22
C (ash)	total s/g	1.8E+09	1.8E+09	7.6E+08
	PCME s/g	3.3E+08	2.6E+08	2.9E+08
	ratio (PCME / total)	19%	15%	38%
Mass of duff fed	g dry wt	4624	4662	4782
Mass of ash recovered	g	2379	2397	2329
Ash/Dry wt ratio	g ash / g duff	0.51	0.51	0.49
Total fibers fed to fire	total LA	4.28E+12	4.21+12	4.32E+12
	PCME LA	7.35E+11	7.41+11	7.60+11
Total fibers recovered in ash	total LA	4.18+12	4.22+12	1.76+12
	PCME LA	7.75E+11	6.25+11	6.68E+11
% Retained in ash	total LA	100%	100%	41%
	PCME LA	105%	84%	88%

Table 4-16. Residual Ash Results from Low Temperature Burn Conditions.

Parameter	**Units**	**Results**		
Sample	--	1	2	3
Burn date	--	02/14/12	02/15/12	02/16/12
Mass suspended	g	0.25	0.25	0.25
Suspension volume	mL	100	100	100
Vol filtered	mL	0.3	0.3	0.3
F Factor	--	0.003	0.003	0.003
GO	--	8	6	8
Ago	mm^2	0.0132	0.0132	0.0132
EFA	mm^2	1280	1280	1280
S	(g ash)$^{-1}$	1.62E+07	2.15E+07	1.62E+07
Counts	total LA structures	57	55	58
	PCME structures	24	17	17
C (ash)	total s/g	9.2E+08	1.2E+09	9.4E+08
	PCME s/g	3.9E+08	3.7E+08	2.7E+08
	ratio (PCME / total)	42%	31%	29%
Mass of duff fed	g dry wt	2313	2261	2337
Mass of ash recovered	g	1090	917	1184
Ash/Dry wt ratio	g ash / g duff	0.47	0.41	0.51
Total fibers fed to fire (number)	total LA	2.09+12	2.04E+12	2.11E+12
	PCME LA	3.68E+11	3.60E+11	3.72E+11
Total fibers recovered in ash (number)	total LA	1.00E+12	1.09E+12	1.11E+12
	PCME LA	4.23E+11	3.36E+11	3.25E+11
% Retained in ash	total LA	48%	53%	53%
	PCME LA	115%	93%	88%

Table 4-17. Proximate and Ultimate Analysis Results for Residual Ash

Analysis	**Method**	**Result**	**Basis**	**Amount**
115: Ash	ASTM D3174-11	95.16 %	Dried and Ground	1052 mg
302: Loss on Drying (LOD)	ASTM D3173-11	0.75 %	As Received	199.9 g
810: Volatile Matter	ASTM D3175-11	5.39 %	Dried and Ground	1052 mg
C : Carbon	GLI Procedure ME-12	1.78 %	Ground	1.79 mg
Cl : Chlorine	GLI Procedure ME-4A	614 ppm	Dried and Ground	506.7 mg
H : Hydrogen	GLI Procedure ME-12	< 0.5 %	Ground	1.79 mg
N : Nitrogen	GLI Procedure ME-12	< 0.5 %	Ground	1.79 mg
S : Sulfur	GLI Procedure E16-2	< 0.5 %	Dried and Ground	42.5 mg
ZZY: Grind	GLI Procedure G-8	Completed	Dried	Direct

4.3 Temperature Results

4.3.1 High-Temperature Run Conditions

Figures 4-1 through 4-3 show the temperature traces for the High Temperature run conditions. The temperature plots shown for the “grate” reflect an average of the temperatures from four TCs, and the plots for 10.16 cm (4-inch) above the grate” reflect an average of two TCs. In general, the temperatures both at the grate and above the grate each fluctuated approximately 100 °C over the course of the run and did not exhibit significant transient behavior in spite of the semi-batch feed nature of the experiments. This stability is likely due to the influence that the propane torch had on providing thermal input over the course of the burn. Across all High Temperature burn conditions, grate temperatures ranged from approximately 700 to 850 °C.

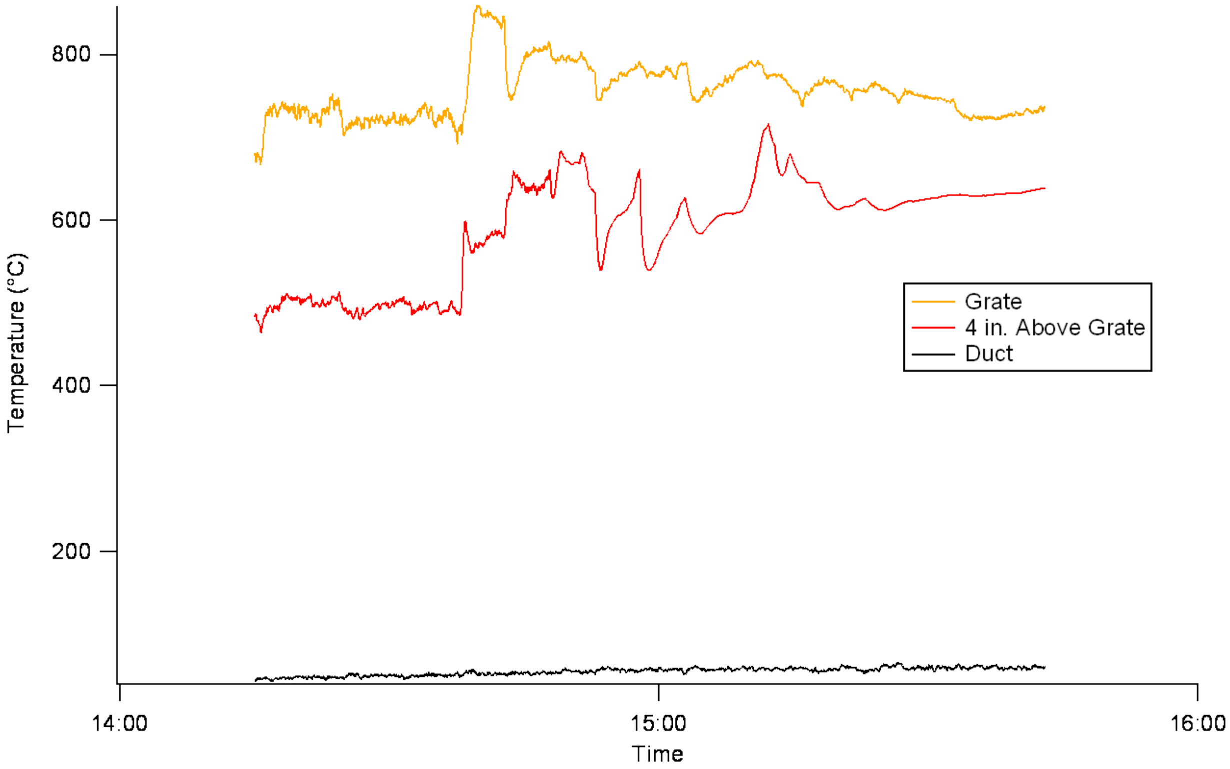

Figure 4-1. Temperatures from High Temperature Run 1.

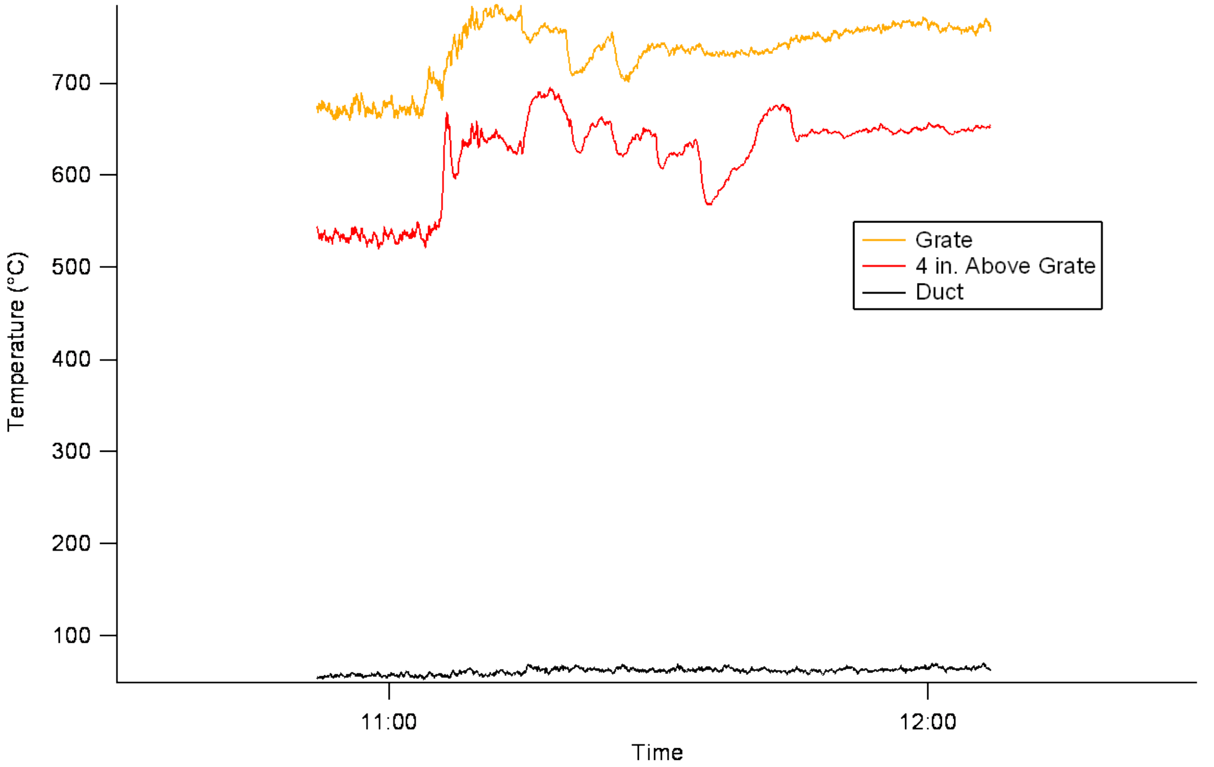

Figure 4-2. Temperatures from High Temperature Run 2.

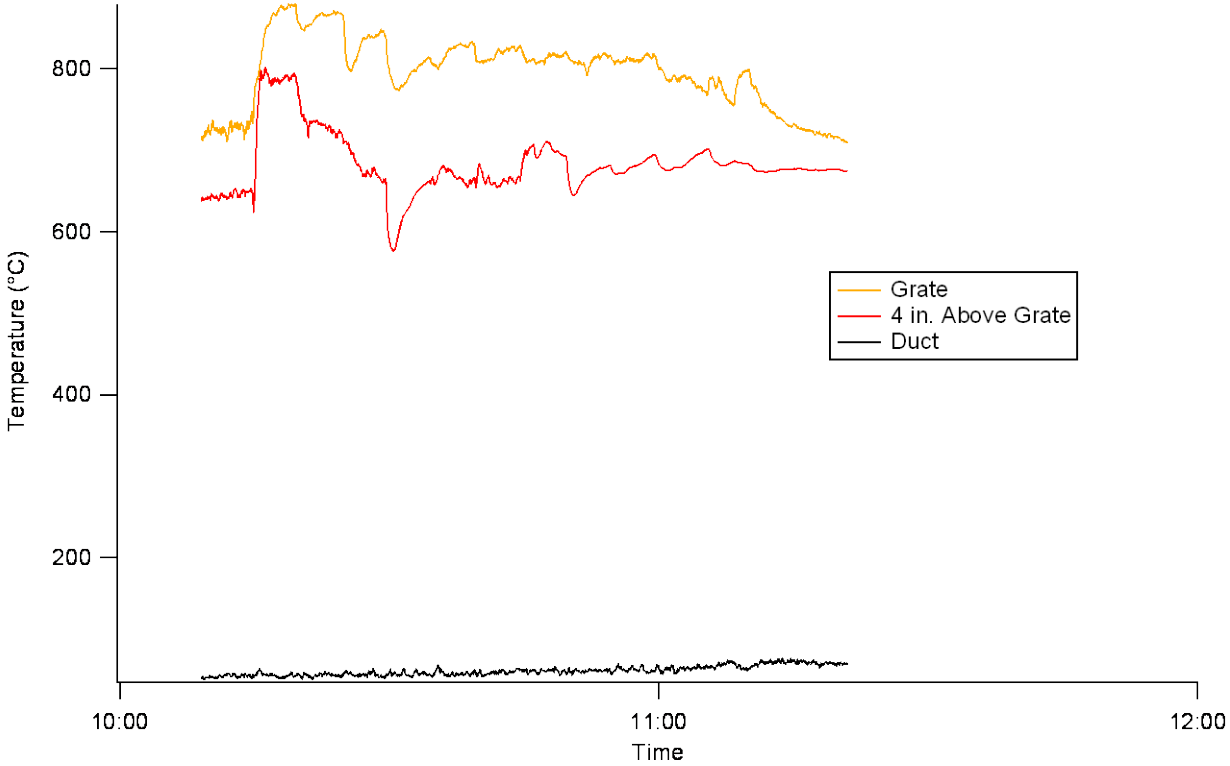

Figure 4-3. Temperatures from High Temperature Run 3.

4.3.2 Low Temperature Run Conditions

Figures 4-4 through 4-6 show the temperature traces for the Low Temperature run conditions. As in the High Temperature results, the temperature plots shown for the “grate” reflect an average of the temperatures from four TCs, and the plots for 10.6 cm (4-inch) above the grate reflect an average of two TCs. Unlike the High Temperature run conditions, the Low Temperature conditions started with the grate temperatures on the order of 100 °C and gradually crept up to 400-500 °C, where they remained. This transient behavior is likely due to the lack of the constant thermal input from the propane torch over the course of the burn. Across all Low Temperature burn conditions, grate temperatures ranged from approximately 100 to 500 °C.

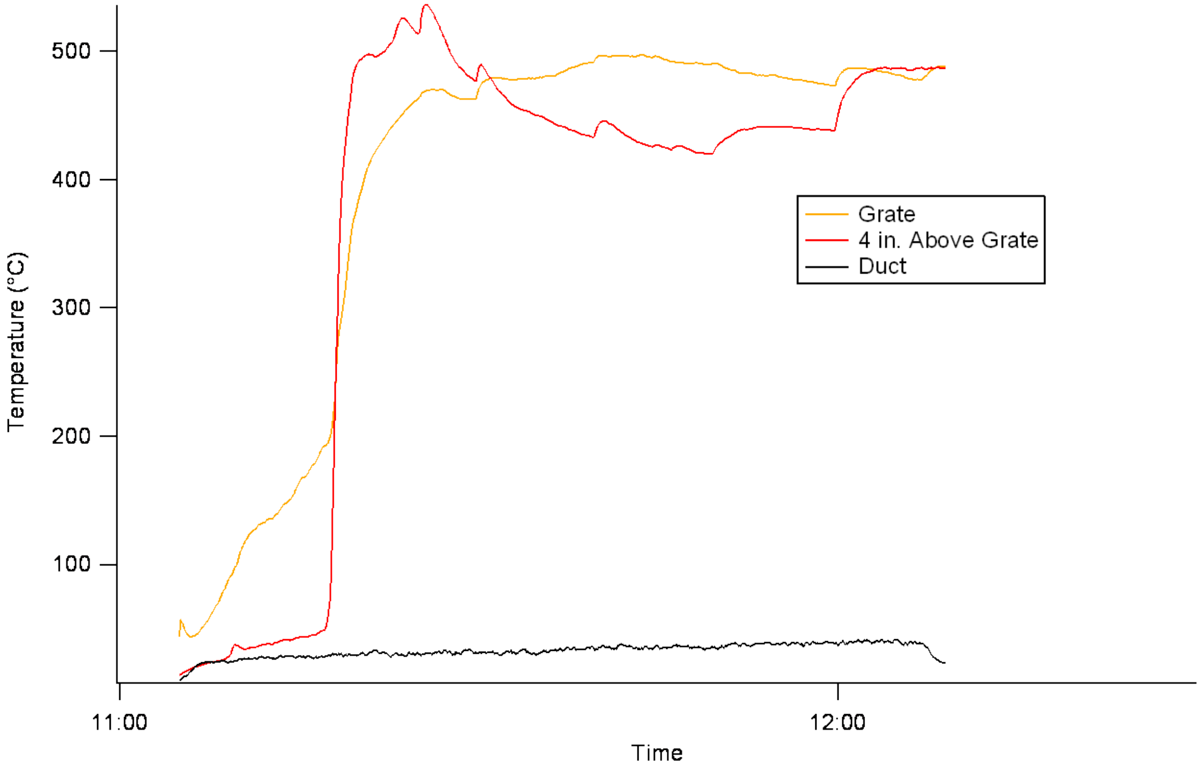

Figure 4-4. Temperatures from Low Temperature Run 1.

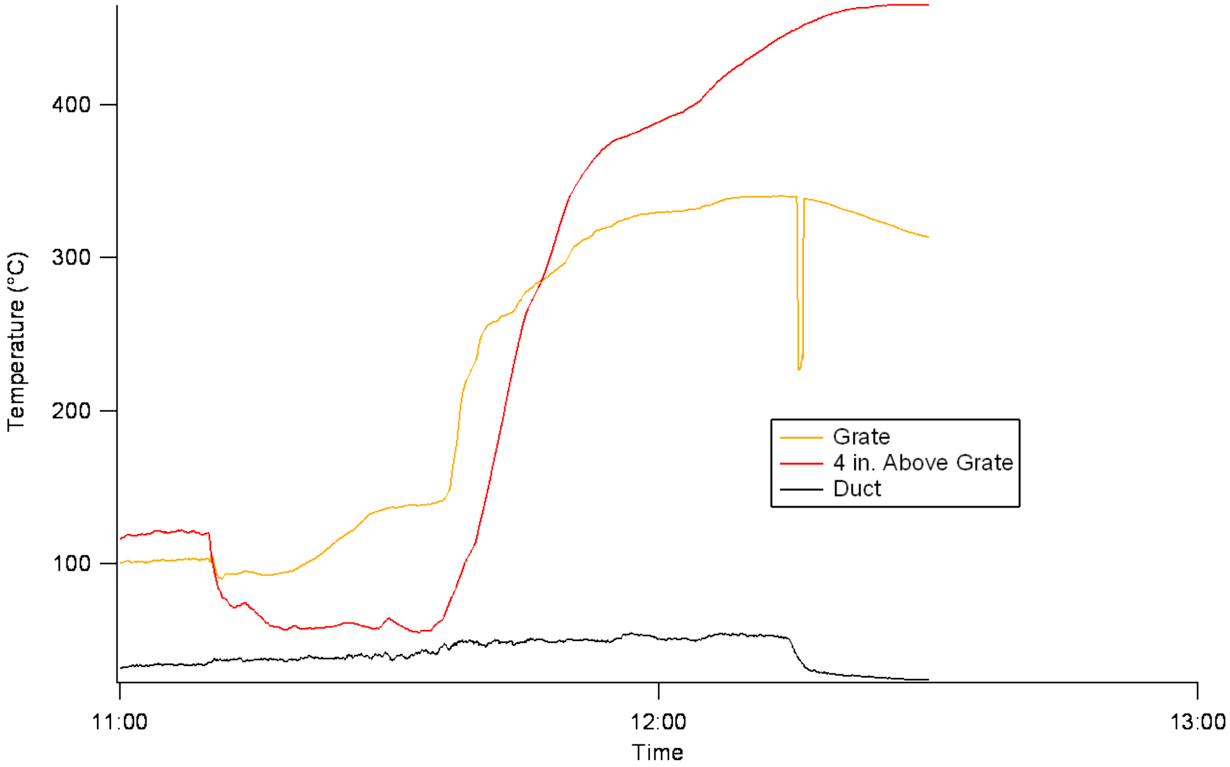

Figure 4-5. Temperatures from Low Temperature Run 2.

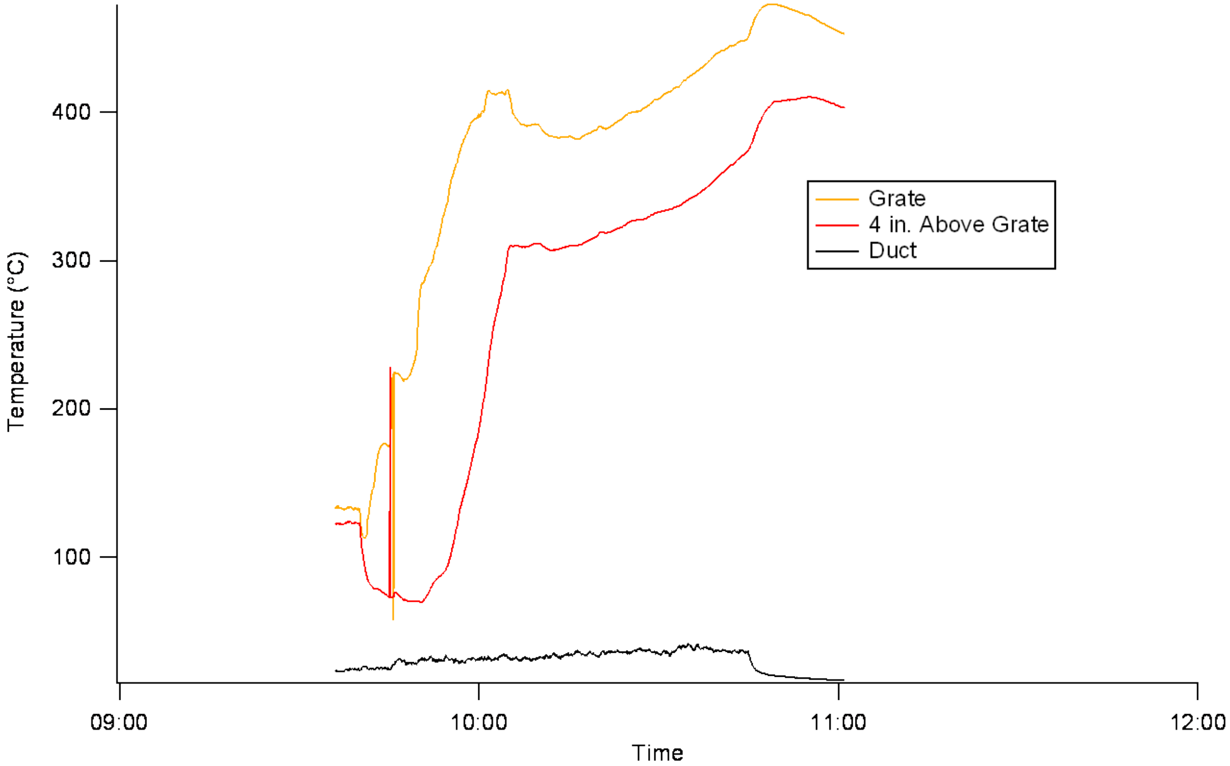

Figure 4-6. Temperatures from Low Temperature Run 3.

4.4 CEM Results

4.4.1 High Temperature Run Conditions

Figures 4-7 through 4-9 depict the CO_2 and CO emissions measured in the exhaust duct for the High Temperature run conditions. CO_2 emissions ranged from approximately 2300 ppm to approximately 4000 ppm across all of the runs, with minor fluctuations corresponding to feed events. CO emissions were in the 50-75 ppmv range across all the High Temperature runs. The contribution to CO_2 is heavily influenced by the high firing propane burner. CO and CO_2 are used to determine the temporal burning rate of the duff in the Burn Hut.

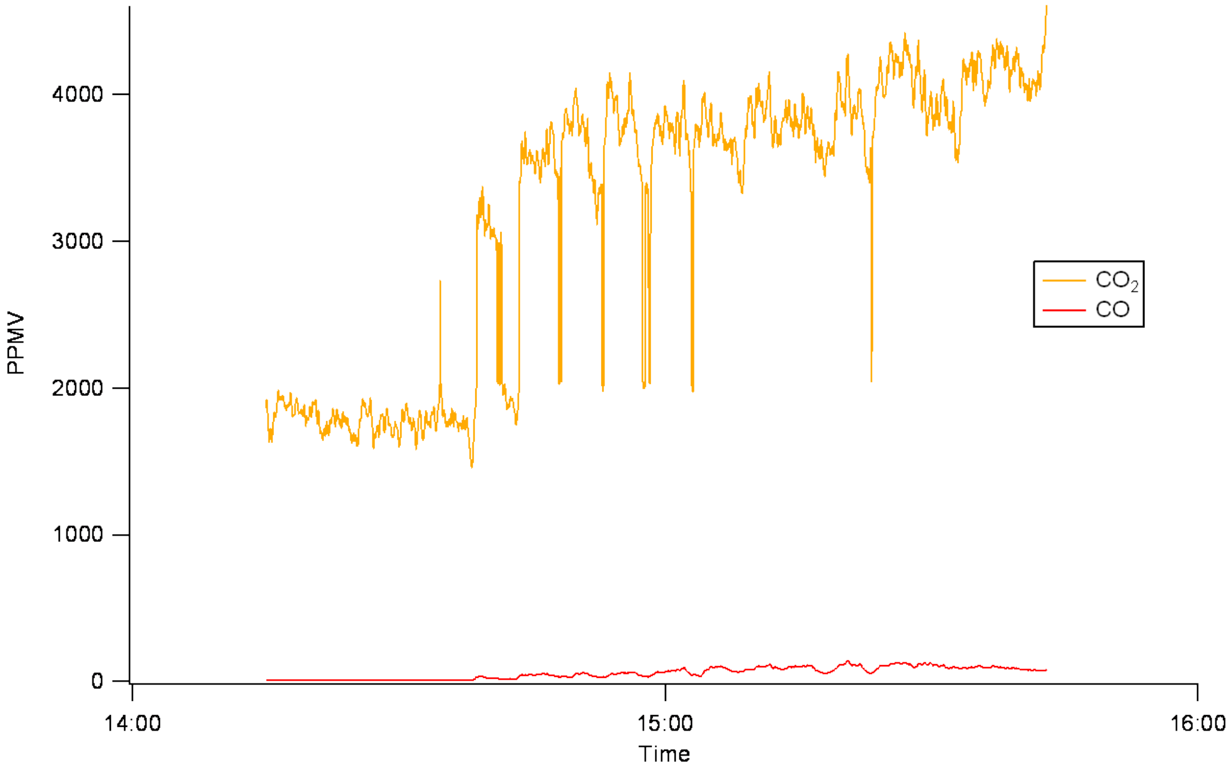

Figure 4-7. CO_2 and CO from High Temperature Run 1.

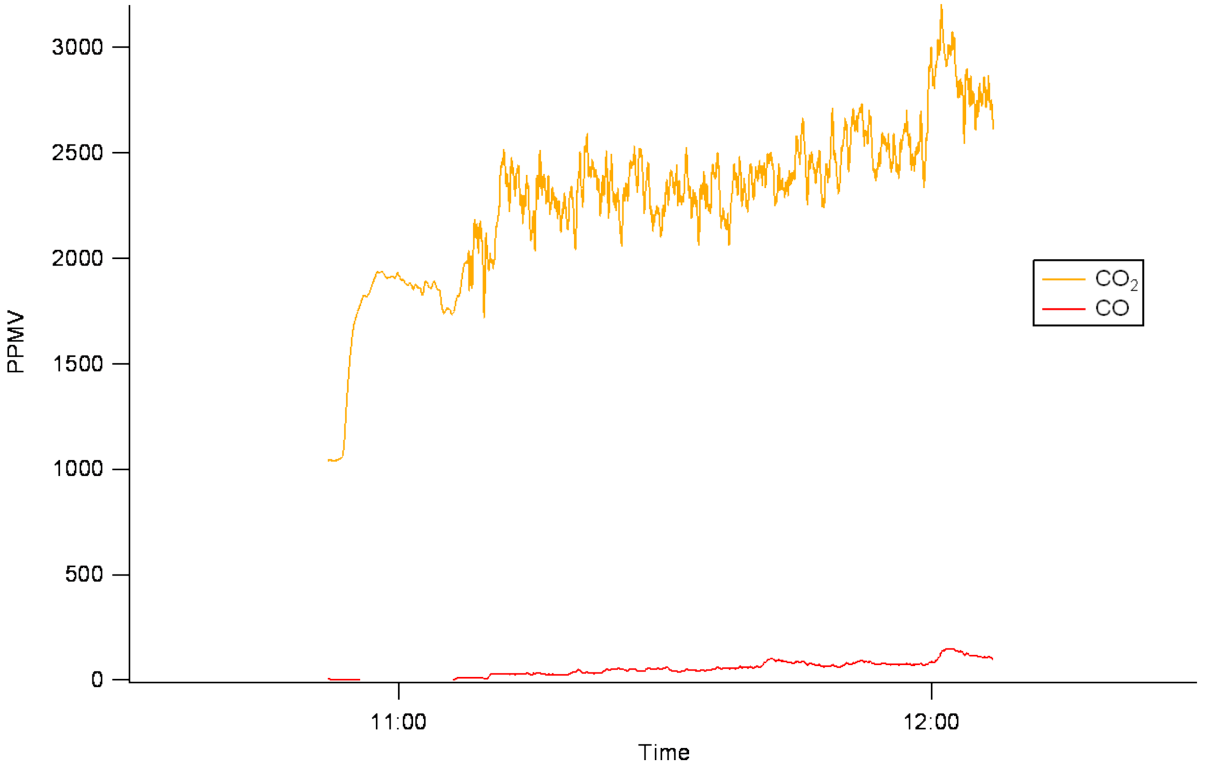

Figure 4-8. CO_2 and CO from High Temperature Run 2.

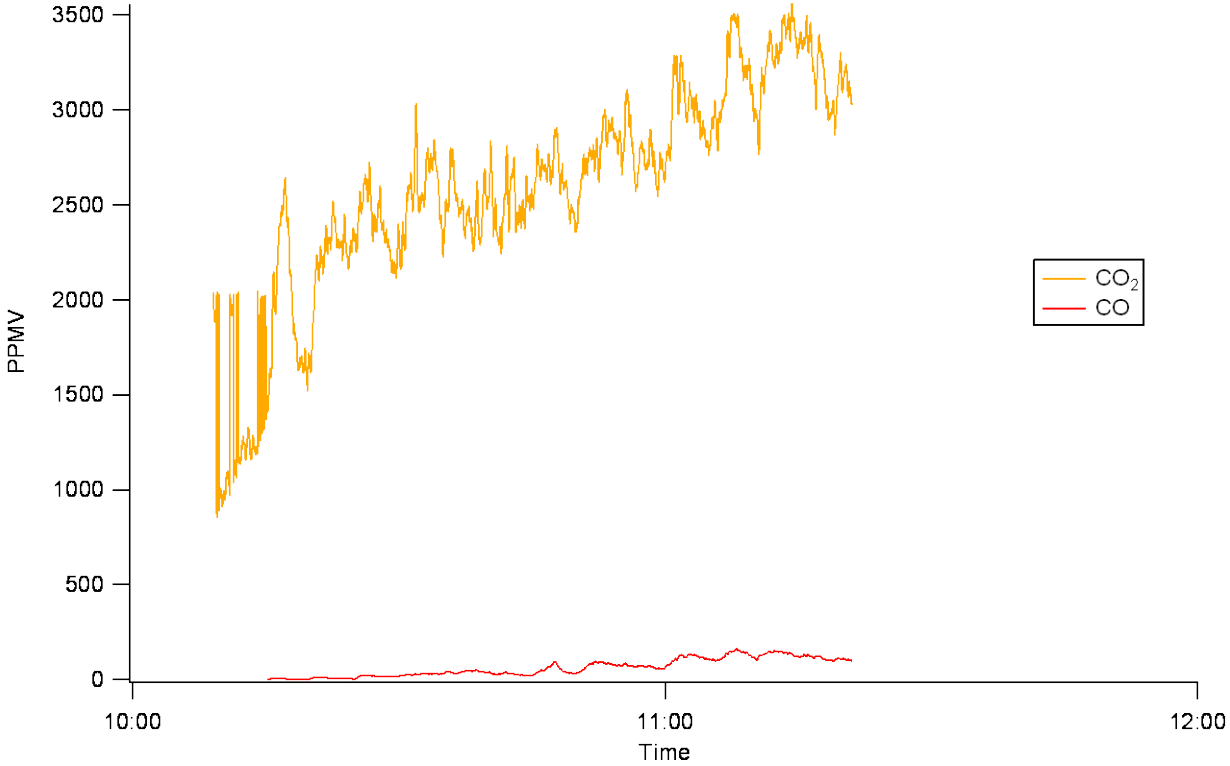

Figure 4-9. CO_2 and CO from High Temperature Run 3.

4.4.2 Low-Temperature Run Conditions

Figures 4-10 through 4-12 depict the CO_2 and CO emissions measured in the exhaust duct for the Low Temperature run conditions. CO_2 emissions ranged from approximately 700 ppm to approximately 2100 ppm across all of the runs, with minor fluctuations corresponding to feed events. CO emissions were in the 20-80 ppmv range across all the Low Temperature runs. The contribution to CO_2 is less influenced by the contributions from the propane torch due to the lower firing rate of the torch.

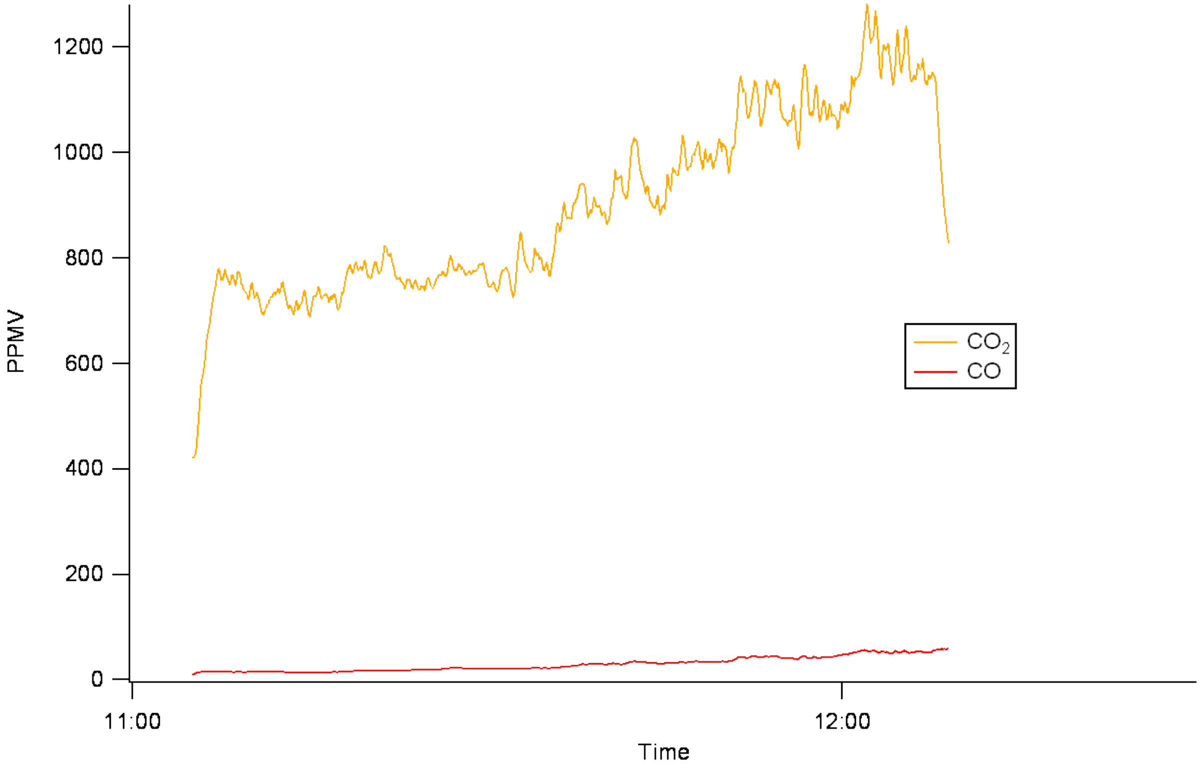

Figure 4-10. CO_2 and CO from Low Temperature Run 1.

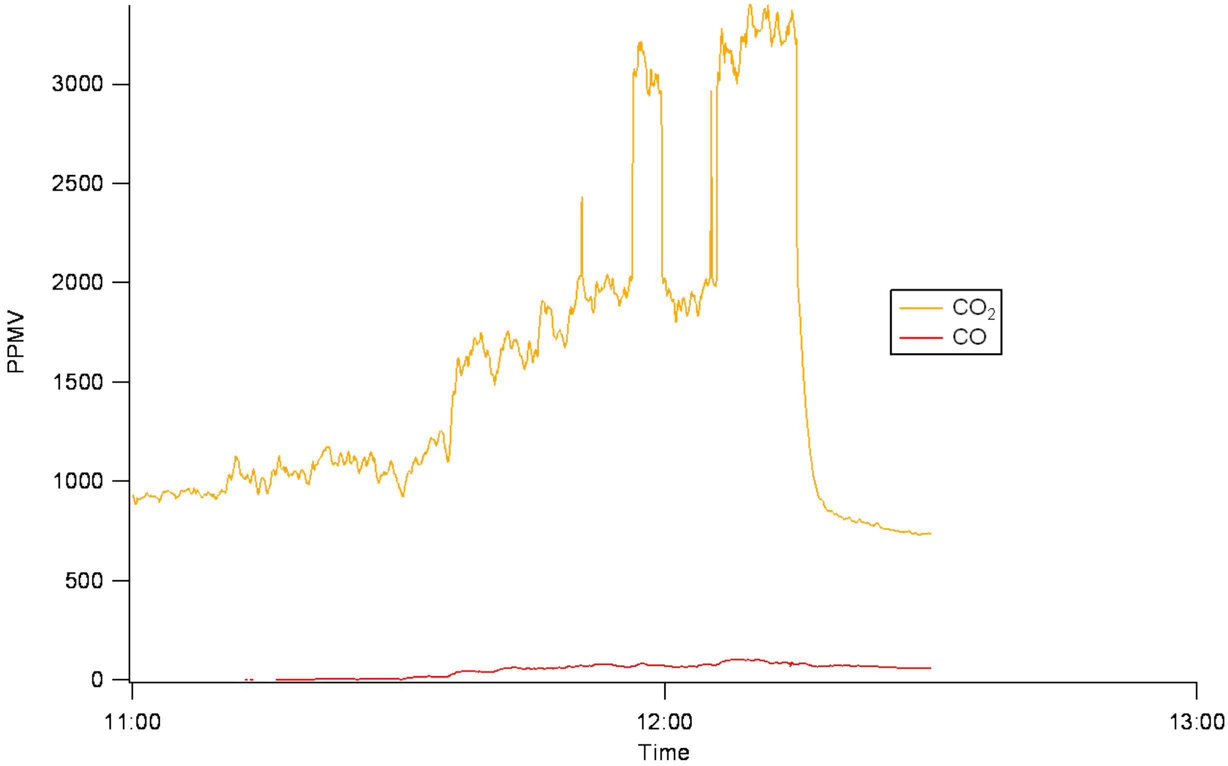

Figure 4-11. CO_2 and CO from Low Temperature Run 2.

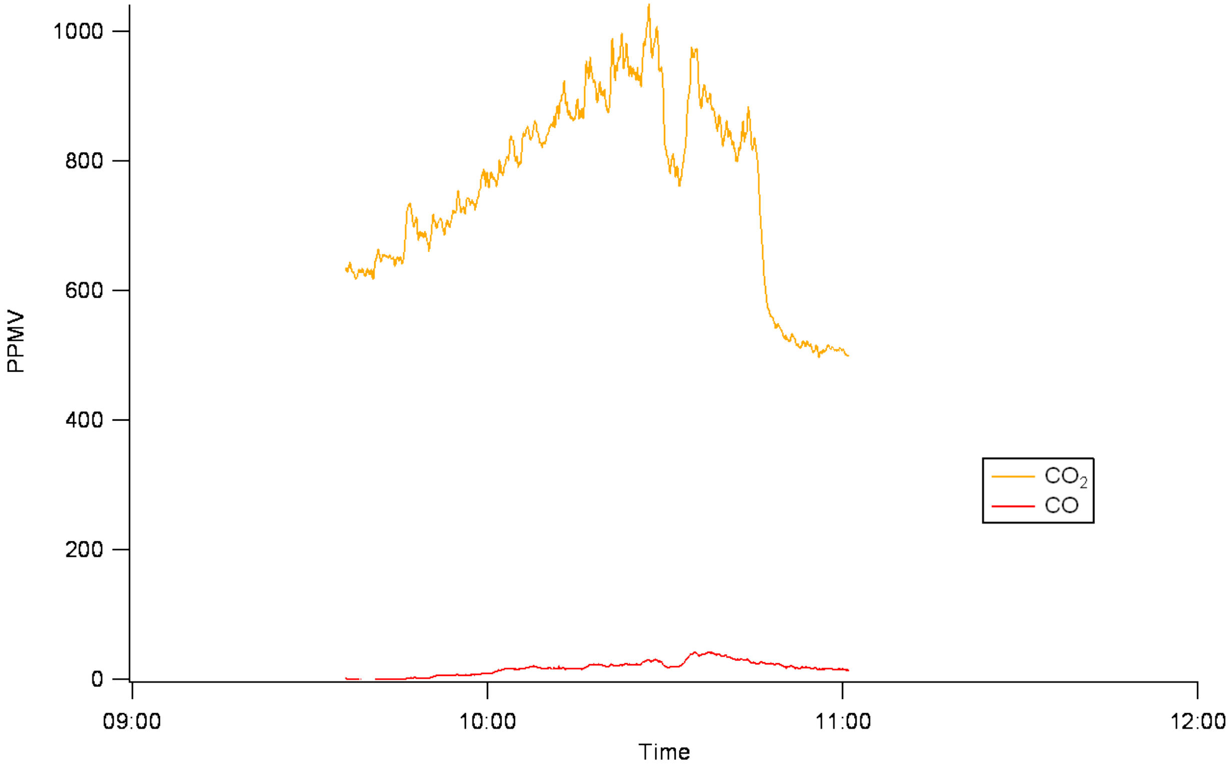

Figure 4-12. CO_2 and CO from Low Temperature Run 3.

4.5 Carbon Balance

A carbon mass balance was completed for the high and Low Temperature conditions using the initial carbon in the duff material. The carbon generated from the duff only is about the same order of magnitude as the carbon generated from the propane burner. To determine the carbon emitted from the burner, the ambient CO_2 was subtracted from the total CO_2 emitted from the burner (pre-duff burning); similarly, in order to determine the carbon emitted from the duff only, the CO_2 emitted from the burner (pre-duff burning) was subtracted from the combined burner propane/duff burning. For the High Temperature setting, 82% of the total carbon fed was emitted as CO_2 and CO during the first hour of burning, while about 2.6% was recovered in the ash 24 hours after testing. For the Low Temperature conditions, the average of carbon emitted during the first hour burning is about 53% while about 2.2% was recovered in the ash 24 hours after testing. The remaining carbon was burned out over the next 24 hours of the smoldering process. These carbon mass balances were conducted using an average of three burns for each temperature conditions. These results track the mass loss results reported in Section 3.15.8 comparing the two burn conditions.

4.6 Summary of Results

Table 4-18 lists the summary of results from the High Temperature burn conditions and Table 4-19 lists the summary of results from the Low Temperature burn conditions, including the estimated emissions of LA per kg of duff burned and the estimated emissions of $PM_{2.5}$ in g per kg of duff burned. These two numbers, along with the initial concentration of LA fibers in the duff, are the main parameters that would be used for subsequent exposure calculations (see Section 4.7).

It should be noted that there was relatively good precision on the calculated emission factors and measured asbestos concentrations (i.e., order of magnitude variabilities are commonplace with asbestos measurements). However, the duff feed was homogenized upon collection prior to packaging for the burn experiments, and the majority of the LA remained behind in the residual combustion ash, therefore it is not entirely unexpected that good reproducibility was observed across tests, with approximately a factor of three between the lowest and highest calculated emission factor.

Table 4-18. Summary of Results* from High Temperature Burn Conditions.

Run	**1**	**2**	**3**		**Mean (1-3)**
Date	12/19/11	12/22/11	12/28/11		all
Burn temperature (°F)	1,543	1,537	1,611		1,564
Concentration of PCME LA in Duff s/g duff (dry wt)	1.59E+08	1.59E+08	1.59E+08		1.59E+08
Concentration of LA in smoke (PCME s/cc)	2.09	0.59	2.44		1.71
Emissions of LA (PCME s/kg duff)	9.33E+05	2.29E+05	9.50E+05		7.04E+05
LA Fraction relative to smoke	0.53%	0.13%	0.54%		0.40%
LA Fraction retained in ash	105%	84%	88%		92%
Conc of $PM_{2.5}$ in smoke (mg/m^3)	26.9	21.6	15.6		21.4
Emissions of $PM_{2.5}$ (g/kg of duff burned)	12.0	8.5	6.1		8.8
Emissions of LA Fibers per mass of PM emitted, per initial fiber concentration in duff LA / $PM_{2.5}$/Cduff (PCME s/cc per mg/m^3 per f/g)	4.9E-10	1.7E-10	9.9E-10		5.5E-10

* LA results from impinger samples were used in this analysis.

Table 4-19. Summary of Results* from Low Temperature Burn Conditions.

Run	**1**	**2**	**3**		**Mean (1-3)**
Date	02/14/12	02/15/12	02/16/12		all
Burn temperature (°F)	729	488	658		617
Concentration of PCME LA in Duff s/g duff (dry wt)	1.59E+08	1.59E+08	1.59E+08		1.59E+08
Conc of LA in smoke (PCME s/cc)	0.11	0.16	0.21		0.16
Emissions of LA (PCME s/kg duff)	1.0E+05	1.5E+05	1.9E+05		1.5E+05
LA Fraction rel to smoke	0.06%	0.09%	0.11%		0.08%
LA Fraction in ash	115%	93%	88%		99%
Conc of $PM_{2.5}$ in smoke (mg/m^3)	17.4	19.8	20.7		19.3
Emissions of $PM_{2.5}$ (g/kg of duff burned)	16.1	18.3	18.1		17.5
Emissions of LA Fibers per mass of PM emitted, per initial fiber concentration in duff LA / $PM_{2.5}$/Cduff (PCME s/cc per mg/m^3 per f/g)	3.9E-11	5.2E-11	6.5E-11		5.2E-11

* LA results from impinger samples were used in this analysis.

4.7 Example Calculation of Input Parameters for Exposure Models

These laboratory simulation experiments were all run using raw duff samples that were collected in the near vicinity of each other, with an average LA concentration of 1.59×10^{11} PCME structures per kg of duff and a standard deviation of 5.9×10^{10} PCME structures per kg of duff. This indicates approximately a factor of 2 spread in the potential EF values. It is desirable to be able to use the results from these experiments to perform exposure assessments for combustion of duff that contains very low numbers of LA fibers (such as the duff from forests located far from the vermiculite mine), and for duff that contains high numbers of LA fibers, (such as the duff located in the near vicinity to the mine).

In order to convert the emission factors into numbers that would be useful for this approach, there are a few inherent assumptions that must be made. An inherent assumption in these experiments was that one LA fiber is not influenced by the presence or absence of other LA fibers, and that the mass of LA fibers in the air emissions is negligible when compared to the mass of $PM_{2.5}$. These two assumptions allow the following estimates to be made over a range of concentrations of LA fibers in the duff, so exposures can be estimated in areas near to the vermiculite mine where concentrations of LA fibers would be the highest, out to areas where LA concentrations are low.

Equation (3) estimates the emissions of LA in PCME structures per kg of duff (EF_{duff}) based on an arbitrary LA concentration in the duff (C_{duff}).

$$EF_{duff}(\text{structures emitted} / kg\ \ duff) = \frac{C_{duff}}{1.59x10^{11}} \tag{3}$$

If one substitutes the concentration of duff from the samples burned in these experiments for the C_{duff} term, the calculated emission factor reverts to the “Emissions of LA” quantity listed in Tables 4-18 and 4-19.

Equation (4) estimates the emissions of LA fibers in PCME structures per gram of $PM_{2.5}$ emitted (E_{duff}) based on the EF_{duff} from Equation (3) and the $EF_{PM2.5}$ from Table 4-18 or Table 4-19.

$$E_{duff}(structures\ \ emitted\ /\ g\ PM_{2.5}) = \frac{EF_{duff}}{EF_{PM\,2.5}} \tag{4}$$

5.0 QUALITY CONTROL EVALUATION REPORT

All measurements that are based on EPA methods utilized calibration and pre-/post-test metrics to assess performance, including leak checks and CEM bias/drift checks. All QC protocols in cited methods were followed. Laboratory QC for TEM analyses was performed in accordance with Libby Laboratory Modification #LB-000029B[26].

The test program consisted of testing and sampling operations under two sets of conditions, High and Low Temperature. Three tests were conducted for each test condition, i.e., testing was conducted in triplicate.

Two hot field blanks (propane flame on only) and one cold field blank were collected. The blank test sampling sequence mimicked the actual testing sequence that was used when burning the duff material. The field blanks were sampled at each temperature condition and for the same period as the test samples. The blank samples were recovered exactly as the test samples. Analytical results for the blank samples were used principally to demonstrate the absence of contaminants in these sample groups.

5.1 Amendment to the QAPP

This project was performed under an approved Category I, (Enforcement Final), QAPP entitled, “Detailed QAPP for Activities at the Burn Chamber Facility (12/19/2011)”. Two QAPP amendments were subsequently added: Amendment 1 (12/27/2011) was added to replace a cold blank test stated in the original QAPP with a hot blank (propane flame only), and adding 6 wipe samples to be taken between the two test sequences (High and Low Temperature setting). The second amendment (02/07/2012) was added addressing three items that were discussed during a conference call with Region 8 and other project team members following the completion of the first phase of testing (High Temperature conditions). The modifications to the original QAPP that were addressed in this amendment were:

- Modification of the EPA SOP for asbestos sampling
- Modification of the duff feed rate
- Inclusion of an SOP for Asbestos Wipe Sampling Kit Preparation.

5.2 Technical Systems Audit

A Technical System Audit (TSA) was performed at the OBTF at the start of the High Temperature setting sampling sequence. The audit covered the following topics: quality system documentation; project organization and responsibilities; field sample collection and monitoring; field QA/QC; field documentation; sample handling and custody; and data management. This two-day audit was conducted by Neptune & Company with support from RTI International on December 19 and 20, 2011, to provide EPA with an independent external assessment of field-specific QA activities at the OBTF.

The TSA audit report did not contain any findings, but two issues related to the quality system documentation were observed. The first issue was to include an up-to-date and completed signature page in the QAPP. The second issue was to include specific steps in the EPA referenced standard methods in the QAPP.

The TSA report listed the following best practices observed:

- All pumps, thermocouples, and balances were certified within the past year and were traceable to a NIST standard. The calibration certificates were kept on-site for easy review and verification of equipment serial numbers to calibration certificates made for easy comparison;
- All gases used to monitor and calibrate the CEMs were EPA protocol gases and contained a certificate of analysis;
- A dedicated laboratory notebook for this project ensured that only project specific notes were being retained; and
- The scanning of notebook pages, Chain of Custody forms, and FDS forms and including these scans as part of the permanent data packages allowed for an easy chain of reference throughout the entire test and provided data traceability.

5.3 Calibration of Sampling/Monitoring Equipment

There were standard operating procedures for the maintenance and calibration of all laboratory equipment. All equipment was verified as being certified calibrated or having the calibration validated by EPA's on-site (RTP, NC) Metrology Laboratory at the time of use. Each piece of equipment being used for testing contained a calibration sticker indicating that the equipment was within tolerance, the date of calibration, and serial number.

All instruments including pumps, Pitot tubes, thermocouples, and balances were calibrated prior to the start of the testing. The instruments were adjusted to meet calibration tolerances and recalibrated within 24 hours, if necessary. If tolerances were not met after recalibration, additional corrective action was taken, possibly including recalibration or/and replacement of the equipment. Table 5-1 lists the calibration frequency of the instruments used in the tests.

Table 5-1. Instrument Calibration Frequency

Equipment	Calibration/Certification	Expected Tolerance
Thermocouples	Compare to independent NIST thermometer (this is a thermometer that is recertified annually by either NIST or an International Organization for Standardization (ISO)-17025 facility) value once per quarter	± 1°C
Stopwatch	Compare against NIST Official U.S. time at http://nist.time.gov/timezone.cgi?Eastern/d/-5/java once every 30 days.	± 1 min/30 days
Clock	Compare to office U.S. Time @ time.gov every 30 days.	± 1 min/30 days
Pressure Guage	Compare to independent NIST Pressure gauge annually.	± 2 psi
Scale	Check calibration with Class 2 weights	± 0.1% weight

5.4 Achievement of Data Quality Indicator (DQI) Goals

5.4.1 Critical Measurements

Target acceptance criteria for the critical measurements in terms of bias and completeness are shown in Table 5-2. All the critical measurements met the acceptance criteria set in the QAPP, with the exception of the asbestos measurements from the MCE filters. The concern over potential MCE filter sampling failure due to the non-standard use of an ambient method inside a relatively High Temperature stack is what led the authors to perform the second type of asbestos sampling that used the impinger method, so that this critical measurement could be made even if one of the two sampling methods did not work. So although the MCE filter method failed, asbestos measurements were made in accordance with the QAPP.

5.4.2 Secondary Measurements

Target acceptance criteria for the secondary measurements are shown in Table 5-3 (for High Temperature burn conditions) and Table 5-4 (for Low Temperature burn conditions) with calibration error, system bias, and system bias for each test. In general the CEM measurements met the data validation criteria set in the QAPP. One low range CO_2 analyzer failed during Test 2 of the High Temperature burn conditions. The measurements for CO_2 were taken by the alternate high CO_2 analyzer. The calculations of the calibration error, bias, and drift were performed in accordance with EPA Method 7E[27].

Table 5.2. Performance Criteria for Critical Measurements

Measurement Parameter	**Sampling Method(s)**	**Calibration/Certification**	**Analysis Method**	**QA/QC**		**Completeness**	
				Acceptance Criteria	**Test Value**	**Accept ance Criteria**	**Test Value**
Burn Hut Exhaust Velocity Traverses	EPA Method 1A	N/A	N/A	N/A	N/A	100	100%
Burn Hut Exhaust Volumetric Flow Rate	EPA Method 2C (to be performed in conjunction with M201A)	Standard Pitot tube	Manometer	± 5% of actual value	± 1% of reading (velocity)	100%	100%
		Gas temperature	K-Type Thermocouple	± 2 °F[2]	1 °F <T<.2 °F	100	100
Burn Hut Exhaust Moisture Content	EPA Method 4 (to be performed in conjunction with EPA Method 201A)	Volume of gas is compared to NIST-traceable dry gas meter before/after the sampling campaign	Standard Meter Comparison	Leak rate less than 4%	0%	100%	100%
		Balance calibration check	NIST traceable Class S weights	± 0.5g	± 0.14g	100%	100%
Burn Hut Exhaust $PM_{2.5}$	EPA Method 201A	Volume of gas is compared to NIST-traceable dry gas meter before/after the sampling campaign	Standard Meter Comparison	Leak rate less than 4%	0.9%	100%	100%
				90 to 110% isokinetic flow	92.1 to 108.7%	100%	100%
		Balance calibration check	Gravimetric S-Class weights	± 0.1 mg	± 0.05 mg	100%	100%
Burn Hut Exhaust Asbestos Sampling	EPA Asbestos Sampling SOP#2015	Post-test meter calibration check	Standard Meter Comparison	± 5% of pre-calibration	0.3%	100%	100 %
	Modified EPA 5 (no filter)	Volume of gas is compared to NIST-traceable dry gas meter before/after the sampling campaign	Standard Meter Comparison	Leak rate less than 4%	0%	100%	100%
Asbestos Analysis of LA in Emitted Sample Material	SOP DUFF-LIBBY-OU3 MCE Filter Samples	N/A	TEM[1]	20-25 fibers per sample being optimal	0% (Fail)	100%	0% (Fail)
Asbestos Analysis of LA in Emitted Sample Material	SOP DUFF-LIBBY-OU3 Impinger Samples	N/A	TEM[1]	20-25 fibers per sample being optimal	100%	100%	100%
Temperature	N/A	Compare against a NIST-traceable thermometer	K-type thermocouple	± 2 °F	1.4-2.1 F	100%	100%

[1] TEM - Transmission electron microscopy; [2] Pre-calibration only:

Table 5-3. Performance Criteria for Secondary Measurements; High Temperature Burn Conditions

Measurement Parameter	**Sampling Method(s)**	**EPA Protocol Gas**	**Sub-parameter**	**Analysis Method**	**Data Quality Validation Criteria**				**Completeness**	
					Acceptance Criteria	**Test 1 Value**	**Test 2 Value**	**Test 3 Value**	**Acceptance Criteria**	**All 3 tests**
Burn Hut Exhaust CO_2 (Low)	EPA Method 3A	1800 ppm	Calibration error	Instrumental calibration gases	± 2%	1.05%	Instrument Failure/Use High CO_2 Instrument	0.05%	90% of test periods	67%
			Sampling system bias		± 5%	1.26%		0.31%		67%
			calibration drift		± 3%	1.92%		0.26%		NA
		1020	Calibration error		± 2%	0.06%		0.20%		67%
			Sampling system bias		± 5%	0.80%		0.37%		67%
			calibration drift		± 3%	0.45%		0.28%		NA
		Zero (Nitrogen Gas)	Calibration error		± 2%	0.18%		0.13%		67%
			Sampling system bias		± 5%	0.11%		0.05%		67%
			calibration drift		± 3%	1.84%		1.62%		NA
Burn Ht Exhaust CO_2 (High)	EPA Method 3A	4.89%	Calibration error	Instrumental calibration gases	± 2%	3.61%	2.00%	0.53%	90% of test periods	67%
			Sampling system bias		± 5%	3.76%	18.30%	2.60%		83%
			calibration drift		± 3%	3.56%	18.12%	0.74%		33%
		2.10%	Calibration error		± 2%	1.32%	2.27%	NM		33%
			Sampling system bias		± 5%	0.62%	0.09%	NM		67%

Measurement Parameter	Sampling Method(s)	EPA Protocol Gas	Sub-parameter	Analysis Method	Data Quality Validation Criteria				Completeness	
					Acceptance Criteria	Test 1 Value	Test 2 Value	Test 3 Value	Acceptance Criteria	All 3 tests
			calibration drift		± 3%	0.41%	0.11%	NM		NA
		Zero (Nitrogen Gas	Calibration error		± 2%	0.20%	0.20%	0.08%		100%
			Sampling system bias		± 5%	3.03%	0.10%	1.89%		100%
			calibration drift		± 3%	2.59%	0.02%	0.29%		NA
Burn Ht Exhaust CO (High)	EPA Method 3A	899 ppm	Calibration error	Instrumental calibration gases	± 2%	0.10%	0.11%	0.18%	90% of test periods	100%
			Sampling system bias		± 5%	0.11%	0.34%	0.20%		100%
			calibration drift		± 3%	0.06%	0.25%	0.29%		NA
		452 ppm	Calibration error		± 2%	0.04%	0.20%	0.09%		100%
			Sampling system bias		± 5%	0.07%	0.06%	0.10%		100%
			calibration drift		± 3%	0.14%	0.06%	0.02%		NA
		Zero (Nitrogen Gas	Calibration error		± 2%	0.04%	0.06%	0.03%		100%
			Sampling system bias		± 5%	0.04%	0.07%	0.20%		100%
			calibration drift		± 3%	0.04%	0.02%	0.01%		NA

Table 5-4. Performance Criteria for Secondary Measurements; Low Temperature Burn Conditions

Measurement Parameter	**Sampling Method(s)**	**EPA Protocol Gas**	**Sub-parameter**	**Data Quality Validation Criteria**				**Completeness**	
				Acceptance Criteria	**Test 1 Value**	**Test 2 Value**	**Test 3 Value**	**Acceptance Criteria**	**All 3 tests**
Burn Hut Exhaust CO_2 (Low)	EPA Method 3A	1800 ppm	Calibration error	± 2%	0.08%	0.12%	0.07%	90% of test periods	100%
			Sampling system bias	± 5%	0.38%	0.01%	0.40%		100%
			calibration drift	± 3%	0.33%	0.04%	0.08%		100%
		1020	Calibration error	± 2%	0.17%	0.02%	0.19%		100%
			Sampling system bias	± 5%	0.15%	0.13%	0.51%		100%
			calibration drift	± 3%	0.00%	0.02%	0.19%		100%
		Zero (Nitrogen Gas)	Calibration error	± 2%	0.09%	0.04%	0.11%		100%
			Sampling system bias	± 5%	0.20%	0.44%	0.13%		100%
			calibration drift	± 3%	0.20%	0.44%	0.00%		100%
Burn Hut Exhaust CO (Low)	EPA Method 10	125 ppm	Calibration error	± 2%	0.02%	0.09%	0.19%	90% of test periods	100%
			Sampling system bias	± 5%	0.02%	0.14%	0.21%		100%
			calibration drift	± 3%	0.33%	0.20%	0.08%		100%
		45.6	Calibration error	± 2%	2.79%	0.49%	0.43%		67%
			Sampling system bias	± 5%	0.26%	0.03%	0.00%		100%

Measurement Parameter	**Sampling Method(s)**	**EPA Protocol Gas**	**Sub-parameter**	**Data Quality Validation Criteria**				**Completeness**	
				Acceptance Criteria	**Test 1 Value**	**Test 2 Value**	**Test 3 Value**	**Acceptance Criteria**	**All 3 tests**
			calibration drift	± 3%	0.24%	0.00%	0.04%		100%
		Zero (Nitrogen Gas	Calibration error	± 2%	0.57%	0.04%	0.12%		100%
			Sampling system bias	± 5%	0.22%	0.04%	0.10%		100%
			calibration drift	± 3%	0.06%	0.12%	0.06%		100
Burn Ht Exhaust O_2	EPA Method 3A	21.60%	Calibration error	± 2%	0.09%	0.27%	0.17%	90% of test periods	100%
			Sampling system bias	± 5%	0.72%	0.13%	1.03%		100%
			calibration drift	± 3%	0.44%	1.10%	0.05%		100%
		8.94%	Calibration error	± 2%	0.09%	0.03%	0.04%		100%
			Sampling system bias	± 5%	0.42%	0.23%	0.86%		100%
			calibration drift	± 3%	0.31%	0.09%	0.11%		100
		Zero (Nitrogen Gas	Calibration error	± 2%	0.05%	0.75%	0.17%		100%
			Sampling system bias	± 5%	0.74%	0.15%	0.80%		100%
			calibration drift	± 3%	0.37%	0.96%	0.15%		100%

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APPENDIX A

Results from Technical Systems Audit

Technical Systems Audit Checklist

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL HOMELAND SECURITY RESEARCH CENTER
CINCINNATI, OHIO 45268

February 14, 2012

MEMORANDUM

SUBJECT: Technical Systems Audit (TSA) Close-out Letter of Quality Assurance Project Plan for "**Burn chamber Study Design Libby Asbestos Superfund Site Operable Unit 3**".

From: Ramona Sherman
NHSRC QAM

To: Paul Lemieux
NHSRC Principal Investigator

This letter confirms the close-out of the assessment of the project entitled "**Burn Chamber Study Design Libby Asbestos Superfund Site Operable Unit 3**" sponsored by the National Homeland Security Research Center on December 19 and 20, 2011. Based on our evaluation of your response to the draft assessment report, we have determined that all deficiencies have been resolved.

Thank you very much for your cooperation and assistance during the assessment. Please contact me if you have any further questions about the assessment.

Respectfully,

Ramona Sherman

Ramona Sherman
Quality Assurance Manager

If you have any questions about the assessment, please call me at 513 569-7640.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL HOMELAND SECURITY RESEARCH CENTER
CINCINNATI, OHIO 45268

January 3, 2012

MEMORANDUM

SUBJECT: Technical Systems Audit (TSA) Summary Report of the project titled **"Activities at the Open Burn Chamber Facility"**

FROM: Eletha Brady-Roberts
NHSRC DQA

TO: Paul Lemieux, Ph.D
NHSRC Principal Investigator

For your consideration, I have attached the summary report of our observations and findings from the TSA conducted in December 19 and 20, 2011.

Audit Scope

The main objective of the audit was to evaluate and examine the conformance of the data collection activities to the project specific Quality Assurance Project Plan (QAPP). The review team interviewed ARCADIS employees, reviewed QA files and observed the test being performed in the Burn Hut facility.

Audit Summary Report

The report contains no findings. However, two issues observation were noted that require corrective action. You are asked to review the report for any technical errors and to provide that information to me.

Audit Schedule

I request your response to this draft report within 15 days of receipt. Thank you in advance for your timely review and response. When the observations have been addressed, we will close out the audit and send confirmation.

Please distribute this memo to your contractor. If you have any questions about the upcoming assessment, please call me at 513 569-7662.

cc: Shawn Ryan, Ph.D, Division Director DCMD
Gregory Sayles, Ph.D. Acting Deputy Director for Management

INTRODUCTION: A technical systems audit was performed at the EPA (ARCADIS operated) Open Burn Test Facility located in Research Triangle Park, North Carolina. The audit covered the following topics: quality system documentation; project organization and responsibilities; field sample collection and monitoring; field QA/QC; field documentation; sample handling and custody; and data management.

This two-day audit was conducted by Neptune & Company with support from RTI International on December 19 and 20, 2011, to provide EPA with an independent external assessment of field-specific quality assurance (QA) activities at the Open Burn Test Facility (OBTF) operated by ARCADIS. The assessment was performed by comparing actual field practices and documentation to the requirements specified in the project's quality assurance project plan (QAPP) titled "*Detailed QAPP for Activities at the Burn Chamber Facility*" and the Office of Research and Development (ORD) Policies and Procedures Manual (PPM), Chapter 13.2 *Paper Laboratory Records*, issued December 12, 2006. The checklist was provided to field personnel prior to the audit.

A series of photographs were collected during the audit, these are provided as a separate file in Appendix A. The auditors completed checklists are also provided with this report as separate pdf files.

PERSONNEL INTERVIEWED:

The ARCADIS personnel shown in the table below were interviewed as part of this technical systems audit. Without exception the ARCADIS staff was very knowledgeable, approachable, and cooperative to suggestions about improving the defensibility of their data and the reliability of their methodology.

Monday December 19, 2011	
Entrance Briefing: Ms. Eletha Brady-Roberts (EPA, NHSRC QAM); Dr.D Paul Lemieux (EPA-WAM); Ms. Libby Nessley (ARCADIS, QA Officer); Dr. Abderrahmane D Touati (ARCADIS -WAL), Mr. John Nash (ARCADIS); Mr. Jeff Portzer (Co-auditor RTI International); and Mr. Steven Walters (Co-auditor RTI International).	
ARCADIS Burn Hut Personnel	**Phone / Email**
Dr. Abderrahmane Touati (Work Assignment Leader)	919-541-3662 / dahman.touati@arcadis-us.com
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John Nash (Field Personnel)	919-541-3362 / john.nash@arcadis-us.com
Steve Terll (Field / Sample Custodian)	919-541-1569 / steve.terll@arcadis-us.com
Daniel Janek (Field Personnel)	919-541-2928 / danel.janek@arcadis-us.com
Justin Ashley (Field Personnel)	919-541-2847 / robert.ashley@arcadis-us.com
EPA / NHSRC Personnel	**Phone / Email**
DrD. Paul Lemieux (Work Assignment Manager)	919-541-0962 / lemieux.paul@epa.gov
Mrs. Eletha Brady-Roberts (EPA, NHSRC QAM)	513-569-7662 / roberts.eletha@epa.gov
Assessment Exit Briefing: Ms. Eletha Brady-Roberts (EPA, NHSRC QAM); Ms. Libby Nessley (ARCADIS, QA Officer);	

Mr. Steven Walters (Co-auditor RTI International).

Audit Summary

The two-day audit began with an entrance briefing to review the objectives of the assessment and to confirm the schedule and format. The audit included an assessment of quality system documentation; project organization and responsibilities; field sample collection and monitoring; field QA/QC; field documentation; sample handling and custody; and data management. The audit also covered aspects from Notebook and other Documentation procedures (PPM 13.2). The audit also included questions that were drawn from the project's QAPP titled "*Detailed QAPP for Activities at the Burn Chamber Facility*," which is an appendix to another approved QAPP "OU3 Burn Chamber SAP," prepared by the US. EPA Region," September, 2011. The QAPP was written as aCategory I enforcement quality system document. This document was formatted based on the U.S. EPA Guidance Document, "*EPA Requirements for Quality Assurance Project Plans EPA QA/R-5*." The QAPP focused on field sampling practices; equipment set up; quality system documentation; data quality objectives; data management; and sample handling. ARCADIS developed a Health and Safety Plan (HASP) that focused on proper asbestos sample handling; decontamination of asbestos contaminated areas; and proper disposal of hazardous materials (asbestos particulates). All on-site personnel involved with the field sampling of this project signed the QAPP and HASP indicating that they have read and understood the documents. At the end of the assessment an exit briefing was held with Ms. Eletha Brady-Roberts and Ms. Libby Nessley to go over observations or issues identified during the audit that were not in complete compliance with project's QAPP and to discuss best practices identified.

Each proceeding numbered section summarizes aspects covered in the questionnaire. If any inconsistencies are identified recommended corrective actions are provided at the end of each numbered section. Issues with recommended corrective actions (Items 1 and 3) are considered Observations as defined in the SOP for Contractors Performing Audits for NRMRL SOP.QA.003.02.

1. **Quality System Documentation**: There is a copy of the approved QAPP on site for reference during field sampling; however the QAPP is lacking a completed signature page. All personnel involved with field sampling have signed a blank page in the QAPP indicating they have read and understood the QAPP. Any "small" changes or deviations (i.e. sampling feed rate) from the QAPP will be sent via email to Ms. Brady-Roberts for approval. Any "large" changes (i.e. a complete redesign in burn chamber) will have to be approved by EPA Region 8 personnel. All changes that are approved will be placed in a separate section of the three-ring binder containing the original QAPP. This three-ring binder will also maintain field data sheets (FDS) and chain of custody (CoC) forms for each test being performed. A dedicated, single hard bound lab notebook (S/N #23355) is used to document all field practices including CEM calibration and drift. This notebook is dedicated only to this project's work. Each entry into the notebook was signed and dated by the record keeper and all entries are made with indelible ink. All corrections are made with single strike through marks with the initials of the individual making the correction including the date of correction. This notebook is kept on site in the control room that houses the

continuous emission monitors (CEMs), data acquisition system (DAS), and sampling pumps. All samples collected contain an FDS form. All notebook entries are scanned to become part of the electronic record, and all electronic records are backed up regularly using flash drives. A data package will be created at the completion of each test which will include all FDS forms, scanned lab notebook pages, analytical data, and CoC forms. These data packages will be maintained in electronic form with hard copies maintained in the project's three-ring binder that contains the QAPP, deviations from the QAPP, and the HASP.

There are two issues that were observed that could improve the quality system documentation. The first is to include an up-to-date and completed signature page to the QAPP. Upon review of QAPP prior to the audit, RTI observed that standard stack testing methods are referenced in the QAPP. For example, the Method 5 standard operating procedure is referenced in the QAPP; however specific Method 5 steps are not highlighted.

Recommended Corrective Action: Include a copy of a complete and up to date signature page in the QAPP. RTI also recommends citing or including specific steps taken from standard EPA methods referenced in the QAPP (i.e. Method 5). Method 5 as written contains several options for performing the procedure. Indicate which steps are being used by field personnel. Since changes to the text of the QAPP may not be completed, an alternative to adding steps to the QAPP would be to develop a research operating procedure that highlights all technical process and procedures including sampling methodology and equipment used during this project and add this procedure as an appendix to the current QAPP.

Response to Comments (Abderrahmane Touati)

Filterable $PM_{2.5}$ and Total filterable OM were performed according respectively to EPA Modified Method 201A: Determination of PM_{10} and $PM_{2.5}$ Emissions from Stationary Sources (Constant Sampling Rate Procedure) Particulate Emissions from Stationary Sources, as described in http://www.epa.gov/ttn/emc/promgate/m-201a.pdf, and EPA Modified Method 5: *Determination of Particulate matter Emissions from Stationary Sources,* as described in http://epa.gov/ttn/emc/promgate/m-05.pdf. The modification to both methods are explained in Section B.2.4.2

2. **Project Organization and Responsibilities.** All field sampling at the burn chamber facility is conducted by ARCADIS personnel. All ARCADIS personnel involved with sampling have successfully completed the OSHA 40-hour health and safety training for Hazardous Waste Operations (HAZWOPER). All sampling personnel have also completed their annual 8-hour OSHAHAZWOPER refresher course. Mr. Jerry Revis (ARCADIS Safety Officer) developed a Health and Safety Plan (HASP) and job safety analysis plan that are maintained in the project's dedicated 3-ring binder. All sampling personnel have signed the HASP indicating they have read and understood the HASP. ARCADIS sampling personnel have been trained on proper asbestos sample handling including asbestos decontamination procedures, and proper disposal of asbestos laden material. **Attachment 1** illustrates the project's organizational chart.

Attachment 1: Project Organizational Chart

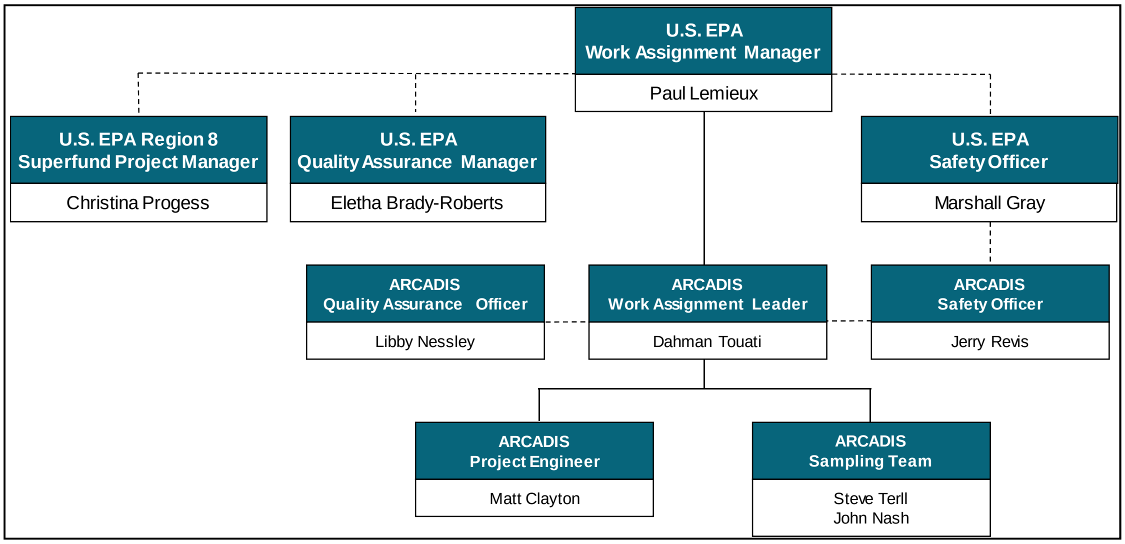


Table 1 below describes the point of contact for the various organizations involved in the project.

Table 1: Points of Contact

ORGANIZATION	CONTACT PERSON
EPA Region 8 Superfund Site	Christina Progess
EPA RTP campus	Paul Lemieux
EPA/NHSRC	Eletha Brady-Roberts
ARCADIS	Dahman Touati
ANALYTICAL LABORATORY	

EMSL Analytical Inc. – Asbestos testing	
Resolution Analytics Inc. – Particulate Matter (PM) testing	

3. **Field Sample Collection and Monitoring (photos of the burn chamber were taken to document actual materials used and burn chamber set up).** The burn chamber was installed and configured according to the technical plans laid out in the project's QAPP with some minor changes. The first change includes the fabrication of a rectangular burn chamber that will hold duff material while it is being burned. The QAPP indicates a cut 55-gallon drum will be used as the burn chamber. The second change is that 6 thermocouples are being used to monitor flame temperature instead of the four thermocouples indicated in the QAPP. Four thermocouples are installed to monitor flame temperature, while the remaining two thermocouples are installed above the flame zone. A working feed chute has been installed to prevent sampling personnel from entering an asbestos contaminated burn chamber in order to add more asbestos-laden duff during testing. All sampling ports including isokinetic sampling modules, CEMs, and sampling trains have been installed and were operational prior to actual burn testing. All pumps and balances being used are within yearly certifications. All balances and pumps were certified against NIST traceable equipment to insure accuracy during operation. All certificates of calibration are kept on-site in the control room for ease of reference. All gas cylinders used for CEM calibration and drift testing are EPA protocol gasses with certificates of analysis available on site for easy review.

   During the audit a high temperature test was observed. During this test the flame's temperature indicated 905 ^{o}C, 868 ^{o}C, 848 ^{o}C, and 697 ^{o}C for the four thermocouples located in the flame zone. The QAPP indicates +/- 2 ^{o}F acceptance window of the target flame temperature (1800 ^{o}F). The flame temperature acceptance window may have to be re-adjusted because of the inherent differences in flame temperatures throughout the entire flame. The target temperature of the flame cannot be maintained with the acceptance window provided in the QAPP. Also, the temperature units listed in the QAPP do not match the temperature units provided by the DAS system. The unit conversion process could produce unreliable data if the unit conversions are not calculated properly. Also, the sampling pump readouts for flows were in cubic feet per minute (cfm) while the QAPP indicated flow targets in liters per minute (L/min). The conversion of units from cfm to L/min could provide unreliable data if the calculations are not completed correctly.

   The duff material provided by EPA Region 8 personnel was pre-weighed by ARCADIS personnel with actual masses recorded on the duff bag and FDS forms prior to the burn test. The masses were entered into an FDS form that is part of the final data package. Upon review of the Chain of Custody (CoC) form for the shipment of duff material to the burn chamber facility, all material provided for the burn chamber testing was from Libby, Montana OU3.

   The feed rate described in the QAPP is **10 lb/hr**. This feed rate was not used during the observed test. During the observed test a feed rate of **12 lb/hr** was used. The CEMs were collecting data 30 minutes prior to the observed burn. The mixed cellulose ester (MCE) filter was located in a cooler area of the exhaust duct; indicating a duct temperature of 118 ^{o}F near the MCE filters cartridge. Upon completion of the high temperature test the remaining ash was collected and sent to EMSL Analytical Inc. for asbestos testing.

The MCE filter collection was observed during the high temperature burn test. During sample collection the first two MCE filter cartridges were sampled without exposing the entire MCE filter in the duct. The last two MCE filter cartridges were sampled by exposing the entire MCE filter in the duct. A negligible pressure drop was observed during the two different MCE filter collections and flows for the two different collections indicated consistent values near the target of 5 L/min. Future MCE filter cartridge sampling will consist of "open faced" sampling where the MCE cartridge inlet cap will be completely removed exposing the entire MCE filter in the exhaust duct.

Recommended Corrective Action: The QAPP needs to be updated to accurately describe the current burn chamber configurations; thermocouple configurations; and duff feed rates. These changes to the QAPP did not indicate approval from EPA's QAM. These differences need to be documented and approved by the EPA QAM.

The QAPP should be amended to describe the method of using the MCE filter cartridges in order to insure that the desired sampling technique will be followed.

Experience has shown that actual flame temperature is difficult to monitor. The inherent variations in flame temperature from one point in the flame to another point in the flame can be difficult to control. The control limits for the target flame temperatures may need to be re-evaluated.

Upon observing MCE filter collections, the auditors noticed the sampled filter cartridges were not carried in the up-right position. Since the flow through the MCE cartridge is low (5L/min) particulates do not get imbedded into the filter media. Rough handling of the MCE cartridges could result in particle loss. RTI recommends carrying the MCE filters cartridges in an upright position at all times. Also by placing "fragile" and "this end up" stickers on the boxes used to ship the MCE cartridges to the analytical lab may limit rough handling by shipping personnel.

Response to Comments (Abderrahmane Touati)

The Final signed version of the QAPP describes the burn chamber configurations, and was approved by the EPA QAM. The control limit for the target flame temperatures were not set due to inherent variations from one point in the flame to another. The target flame temperatures were designated as "Hot Temperature" and "Cold Temperature" settings in the QAPP.

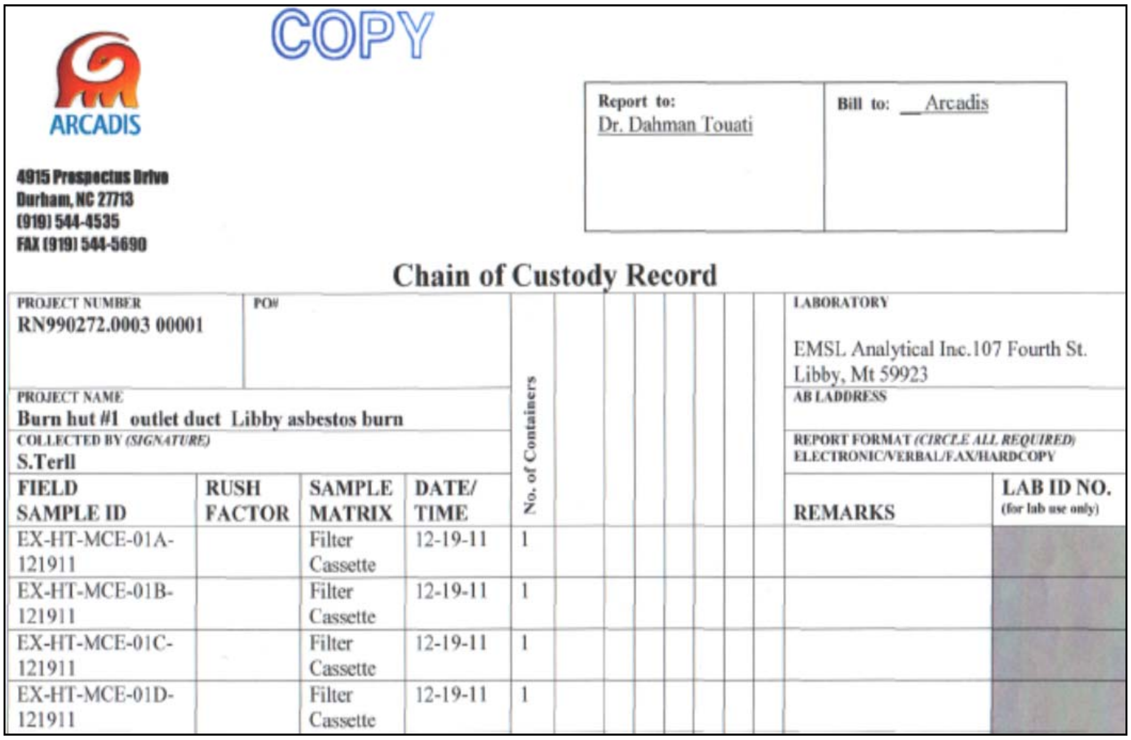
4. **Field QA/QC.** All instruments including pumps, Pitot tubes, thermocouples, and balances are within yearly certifications. The calibration certificates for each instrument being used are up to date and available for review during the audit. The equipment will be certified at the end of testing to insure minimal drift throughout burn chamber testing. The check weights used for the daily balances check are currently out of date but are only used as an initial accuracy check. Each balance was

certified with NIST traceable weights according to the calibration certificates. Each piece of equipment being used for testing contains a calibration sticker indicating that the equipment is within tolerance; the date of calibration; and serial number. The auditor verified the instrument stickers against the calibration certificates for each piece of equipment being used by ARCADIS.

5. **Field Documentation.** All calibration and drift measurements for the CEMs are entered into a dedicated laboratory notebook and FDS forms. All sampling flow rates are entered onto FDS forms. All notebook pages and FDS forms are scanned into an electronic format that is backed up using flash drives. Scanned lab notebook pages and FDS forms are kept based on the unique test ID number with hard copies placed into a specific section of the project's dedicated 3-ring binder.

6. **Sample Handling and Custody.** Mr. Steve Terll of ARCADIS is the dedicated sample custodian who handles all sample shipments to the project's analytical labs. Each sample has a unique sample ID number. The QAPP highlights the sample ID naming scheme and this same naming practice was observed during the audit. Each sample container contains a printed label indicating what the sample contents are. FDS forms are generated for each collected sample. Once samples are recovered and ready for shipment to the lab a single CoC form is created indicating which unique sample ID numbers are being sent to the labs for testing. **Attachment 2** below indicates a typical CoC form generated for sending out MCE filter cartridges to the analytical laboratory.

Attachment 2: CoC form



COPY

ARCADIS

4915 Prospectus Drive
Durham, NC 27713
(919) 544-4535
FAX (919) 544-5690

Report to: Dr. Dahman Touati

Bill to: Arcadis

Chain of Custody Record

PROJECT NUMBER: RN990272.0003 00001

PO#

LABORATORY: EMSL Analytical Inc.107 Fourth St. Libby, Mt 59923

PROJECT NAME: Burn hut #1 outlet duct Libby asbestos burn

AB LADDRESS

COLLECTED BY *(SIGNATURE)*: S.Terll

REPORT FORMAT *(CIRCLE ALL REQUIRED)* ELECTRONIC/VERBAL/FAX/HARDCOPY

FIELD SAMPLE ID	RUSH FACTOR	SAMPLE MATRIX	DATE/ TIME	No. of Containers								REMARKS	LAB ID NO. (for lab use only)
EX-HT-MCE-01A-121911		Filter Cassette	12-19-11	1									
EX-HT-MCE-01B-121911		Filter Cassette	12-19-11	1									
EX-HT-MCE-01C-121911		Filter Cassette	12-19-11	1									
EX-HT-MCE-01D-121911		Filter Cassette	12-19-11	1									

Per the QAPP, before each test a hot blank is to be collected prior to the actual high temperature burn and a cold blank is to be collected prior to a low temperature burn.

All blank samples are to be collected in the same manner as samples collected during the actual burn testing; however neither a hot blank nor a cold blank test collection was observed during the audit. These blanks had been collected on the Friday prior to the audit and this is consistent with the QAPP requirements.

7. **Data Management.** Dr. Abderrahmane (DrDahman) Touati, Ms. Libby Nessley, Mr. Steve Terll, and Mr. John Nash are responsible for on-site data management. All notebook entries, FDS forms, and CoC forms are scanned to become part of the permanent data package. This insures an easy chain of reference from notebook entries to the actual FDS forms to CoC forms generated for collected samples. Hard copies of the scanned documents are kept on-site in the project's dedicated 3-ring binder. Electronic data provided by the DAS is saved to flash drives. The electronic data are also included in the data packages containing notebook entries, FDS forms, and CoC forms. Calculations will be performed using copies of the raw data files. This insures that raw data files are not changed. The electronic data and analytical data will be used by Paul Lemieux, Region 8 EPA personnel, and Dahman Touati. The data will be used to determine exposures to asbestos material contained in wildfire smoke if ever a wildfire occurs at the Libby Amphibole Superfund site near Libby, Montana.

Best Practices Observed

1. All pumps, thermocouples, and balances were certified within the past year and are traceable to a NIST standard. The calibration certificates are kept on-site for easy review and verification of equipment serial numbers to calibration certificates made for an easy comparison.
2. All gasses used to monitor and calibrate the CEMs are EPA protocol gases and contain a certificate of analysis.
3. A dedicated lab notebook for this project insures that only project specific notes are being retained.
4. The scanning of notebook pages; CoC forms; and FDS forms and including these scans as part of the permanent data packages will allow for an easy chain of reference throughout an entire test and provide data traceability.

Technical Systems Audit Checklist-EPA Burn Hut 2 used for Libby Amphibole (LA) Assessment:

Project: Activities as the Burn Chamber Facility
Location: EPA RTP Facility, North Carolina
Date of Audit: December 19 and 20, 2011
Assessor(s): Steven Walters and Jeff Portzer, RTI International,
(Subcontracted by Neptune and Company, Inc., a contractor to EPA).

Project Background:

Asbestos laden materials will be burned at the EPA Burn Hut Facility located in RTP, NC. The exhaust flue gas will be sampled for particulates and gasses. Particulates will be collected using mixed cellulose ester (MCE) filters, as well as, collected using an impinger system similar to EPA Method 5 sample collections. Continuous Emission Monitors (CEMs) will be used to evaluate CO, CO2, and O2. The filter based and impinger collections will be analyzed for asbestos particulate deposits using Transmission Electron Microscopy (TEM).

Technical System Audit Objectives.

To provide the United States Environmental Protection Agency (EPA) with an independent, external quality assurance (QA) assessment of technical activities in the field for Contract No. EP-C-08-007, Task No. 69, Work Order No. 02: Activities as the Burn Chamber Facility

ITEM	**Reference**	***YES***	***NO***	***N/A***	***COMMENTS***
A. QUALITY SYSTEM DOCUMENTATION					
1. Is there a copy of an approved QAPP and SOP on-site for reference during the sampling?	General				
2. Have all field personnel associated with the project read and understood the QAPP and SOP? How is this documented?	General				
3. Are there deviations from the QAPP or SOPs since the project's implementation or scope testing?	General				
4. How are deviations from the QAPP or SOP tracked and documented?	General				
5. How are field measurements and notes being recorded?	General				
6. Do documentation practices adhere to ORD PPM 13.2 (*Paper Laboratory Records*)?	Section A.9 (Documents and Records)				

ITEM	Reference	*YES*	*NO*	*N/A*	*COMMENTS*
Additional Questions or Comments:					
B. PROJECT ORGANIZATION AND RESPONSIBILITIES					
7. Are any contractors involved with the field operations currently planned for?	General				
8. Have all personnel involved in handling, burning, and collecting samples received OSHA 40-hour health and safety training?	Section A.8				
9. Has a specific HASP been developed? Did the sampling crew receive a copy of the HASP before the start of the sampling?	Section A.8				

ITEM	**Reference**	***YES***	***NO***	***N/A***	***COMMENTS***
10. Have all field personnel involved with asbestos sampling at the EPA Burn Hut been trained on proper handling of asbestos-laden material, as well as decontamination of asbestos-laden materials? • How is this training documented?	Section A.8 (Special Training / Certification)				
11. Who will be responsible for: • Maintaining the QAPP and SOP as well as ensuring the completion of all aspects of the QAPP and SOP? • Coordination of the study with state and local agencies? • Quality assurance review/approval of the QAPP and SOP including a QA review/approval of the final report? • Production, collection, and analysis of the flue exhaust conditions at the EPA Burn Hut facility? • Coordinating technical discussion and activities between NRMRL, analytical labs, and ARCADIS? • Coordinating efforts with data collection and reporting activities at the EPA Burn Hut facility?	Section A.4 (Project/Task Organization)				

ITEM	Reference	*YES*	*NO*	*N/A*	*COMMENTS*
12. Who is the point of contact at the following? • EPA Region VIII (Superfund Site) • ARCADIS • Analytical Lab	General				
Additional Questions or Comments:					
C. FIELD SAMPLE COLLECTION and MONITORING					
13. Was the Open Burn Hut Test Facility assembled and configured as described?	Section B.1.1.1 and Figure B.1				
14. Has a working Feed Chute been installed to prevent sampling personnel from entering the burn chamber to add additional fuel (duff) to the fire?	Section B.1.1.2				
15. Was the Burn Chamber assembled and installed as	Section				

ITEM	**Reference**	***YES***	***NO***	***N/A***	***COMMENTS***
described? • Cut drum • Propane burner • Thermocouples (5) positioned correctly • Assembly on scale • Propane tank off-scale • Combustion air fan	B.1.1.3				
16. Is the Burn Chamber equipped with four K-Type thermocouples inserted in a radial fashion to properly monitor flame zone burning temperatures? Is one thermocouples installed above the burn chamber to measure temperature above the flame zone?	Section B.1.1.3				
17. Have all the sampling ports including the isokinetic sampling ports; gaseous monitors; and sampling trains been installed and operational?	General				
18. Was the exhaust flue gas duct, Baghouse, and HEPA filter assembled and installed as described?	Section B.1.1.4				

ITEM	Reference	*YES*	*NO*	*N/A*	*COMMENTS*
19. Have the Baghouse (model 72RT-21) and HEPA filters (AstroCelI Model 905-000-348) been installed according to manufacturer recommendations? Are there are any modifications to this system? Please specify.	Section B.1.1.4				
20. Is the burn chamber mounted on a scale with an accuracy of +/- 0.1 pounds to continuously monitor the mass of fuel remaining? Is this scale NIST traceable? Is the scale certified? How often is the scale certified?	Section B.1.1.3				
21. Was the temperature of the burn controlled within desired tolerance for the “low” burn at 800°F by adjusting propane flame and/or air flow rate?	Section B.1.3 and B.1.3.2.				
22. Was the temperature of the burn controlled within desired tolerance for the “high” burn at 1800°F by adjusting propane flame and/or air flow rate?	Section B.1.2 and B.1.3.2.				
23. Is the source material pre-packaged duff in 0.5 lb paper bags?	Section B.1.2.1				
24. Does the COC for the duff material correctly document that	Section B.1.2.1				

ITEM	**Reference**	*YES*	*NO*	*N/A*	*COMMENTS*
the source is Libby OU3?					
25. Is the feed rate of bags of duff equivalent to the proposed 10 lb/hr? (20 bags/hr @0.5 lb/bag)?	Section B.1.2.2				
26. Was the optimum feed rate for the bags of duff determined from the scoping test?	Section B.1.3.1				
27. Were the O2, CO, and CO2 CEMs and DAD started up and logging data with the DAS 30 minutes before start of burning?	Section B.1.3.2 and B.2.7.2				
28. Was the location of the sampling port for the MCE filters in a location where exhaust flue gas temperatures were sufficiently low?	Section B.2.1.1				
29. Was the location of the sampling port for the impinger method in close proximity to the sampling port for the MCE filter?	Section B.2.1.2				
30. Was the ash sample collected and placed into a glass bottle with label code according to the sample coding scheme?	Section B.2.1.3 and B.3.2				

ITEM	**Reference**	***YES***	***NO***	***N/A***	***COMMENTS***
31. Briefly describe some of the scoping tests conducted and initial observations that may alter current test procedures.	Section B.1.3.1				

ITEM	Reference	*YES*	*NO*	*N/A*	*COMMENTS*
32. Is the following methodology used for Burn Hut test preparations and post test cleanup: • Is PPE being worn by field personnel? • Is the aluminum foil lining removed and placed in appropriately labeled vessels for shipping and storing asbestos contaminated material? • Is an Omega Vac or equivalent vacuum used to remove asbestos contaminated particulates from the burn chamber walls? Is a new inlet hose and filter installed to prevent cross contamination from sample to sample? • Is the vacuum cleaner catch collected and stored in appropriately labeled glass jars in the event this material is used for further analysis?	Section B.1.3.2				
33. Is the mixed cellulose ester (MCE) filter 25-mm diameter and 0.8 µm pore size being used? • What type cassettes are being used?	Section B.2.1.1				

ITEM	Reference	*YES*	*NO*	*N/A*	*COMMENTS*
34. Is the sample air flow maintained at 5 L/min? How is this accomplished?	Section B.2.1.1				
35. Was the Method 5 sampling train set up according the standard method? • Was the filter removed from the standard sampling train?	Section B2.1.2				
36. Was the ash sample collected at the completion of each burn? • Weighed? • Placed into a glass bottle? • Shipped to the analytical lab for analysis of LA?	Section B.2.1.3				
37. Was the Burn Hut exhaust gas volumetric flow rate determined using EPA Method 1A? Was the measurement location 5 feet downstream of the inlet?	Section B.2.2				
38. Was the Burn Hut exhaust gas temperature measured?	Section B.2.3				
39. Was the exhaust gas moisture determined during Method 5 sampling?	Section B.2.3				
40. Was the Filterable PM2.5 sampling performed according to Method 201A?	Section B.2.4.1				

ITEM	**Reference**	***YES***	***NO***	***N/A***	***COMMENTS***
41. Was the Burn Hut exhaust total filterable PM measured according to Method 5?	Section B.2.4.2				
Additional Questions or Comments:					
D. FIELD QA/QC					
42. Are field instruments (e.g. dry-gas flow meters) calibrated or checked for calibration? At what frequency?	General				
43. Are the calibration standards traceable to NIST?	General				
44. Have the CEMs been inspected and function verified before sample collection? • CO2/O2 by EPA Method 3A • CO by EPA method 10	General				

ITEM	Reference	*YES*	*NO*	*N/A*	*COMMENTS*
45. Are the calibration checks of the CEMs meeting the criteria specified in Table A.2 of the QAPP?	Section A.7.3 Table A.2				
46. What is the method and frequency of thermocouple calibration?	General				

Additional Questions or Comments:

E. FIELD DOCUMENTATION

47. How are calibration data for field instruments recorded?	General				

ITEM	Reference	*YES*	*NO*	*N/A*	*COMMENTS*
48. Are readings from field analyses documented in a dedicated waterproof notebook?	General				
Additional Questions or Comments:					
F. SAMPLE HANDLING AND CUSTODY					
49. Is there a dedicated sample custodian on-site? Who?	Section B.3				
50. Does each sample label include a unique labeling system that is described in the QAPP? Are sample ID's written on each sample container in permanent marker or on labels in indelible ink?	Table B.2 Sample Coding				
51. Is there chain of custody forms created for each sample being collected? Are they available for review?	Section B.3.4				
52. Does a Chain-of-Custody accompany each set of coolers?	Section B.3.4				

ITEM	**Reference**	*YES*	*NO*	*N/A*	*COMMENTS*
53. Does each cooler have a custody seal?	General				
54. How often are Field Blanks and Trip Blanks collected?	General				
Additional Questions or Comments:					
G. DATA MANAGEMENT					
55. Is there someone who is the responsible for data management on-site? Who?	Section B.10				

ITEM	**Reference**	*YES*	*NO*	*N/A*	*COMMENTS*
56. Was a hard-bound laboratory notebook with a unique identification number assigned for this project?	Section A.9.1				
57. How are paper records, lab notebook pages and electronic data maintained? Who is responsible for these records?	Section B.10.1				
58. Will post calculations be made to the raw data? Who will be responsible for performing such calculations?	Section B.10.5				
59. Sample Preparation and Collection: • At what point during the testing are the six wipe samples collected? How much surface area should be sampled with each wipe?	Section B.2				

Additional Questions or Comments:

APPENDIX B

Temperature and CEM Data

Test ID		Sampling train Type	Start Time	End Time	Sample Volume	Total Flue gas Volume	Isokineticity
	Type of Blank Sample		EDT		Dry Standard Liters		
Ambient air			10:43	11:01			
EX-PM Hot Blank-01-121511 (burner ON)	Burner ON	Impinger sampling Method for Asbestos	13:48	14:48	1814.6	1863854	100
EX-Hot blank-PM-01-121511		Total PM sampling using EPA Method 5	13:48	14:48	1816.9	1838951	101
EX-Hot Blank-PM2.5-01-121511		PM 2.5 Sampling using EPA 201a	13:48	14:48	777.0	1860732	110
EX-Hot blank-MCE-01B-121511		Asbestos Sampling using SOP-2015	13:48	14:48	156.5	1854512	Non-Isokinetic sampling
EX-PM Air Blank-01-121511	Ambient air inside the burn hut	Impinger sampling Method for Asbestos	11:15	12:15	1061.0	1854875	101
EX-HT-PM-01-121511		Total PM sampling using EPA Method 5	11:15	12:15	1110.4	1856470	101
EX-HT-PM2.5-01-121511		PM 2.5 Sampling using EPA 201a	11:15	12:15	756.4	1854018	115
EX-HT-MCE-01B-121511		Asbestos Sampling using SOP-2015	11:15	12:15	317.0	1855121	Non-Isokinetic sampling
Ambient air			9:45	12:15			
EX-IMP LT Blank-01-021712	Torch ON	Impinger sampling Method for Asbestos	9:45	10:45	1170.9	2042686	100
EX-PM LT Blank-01-021712		Total PM sampling using EPA Method 5	9:45	10:45	1149.9	2038362	100
EX-PM2.5 LT Blank-01-021712		PM 2.5 Sampling using EPA 201a	9:45	10:45	750.4	2045959	110
EX-MCE LT Blank-01-021712		Asbestos Sampling using SOP-2015	9:45	10:45	508.2	2063102	101

Summary Sheet for HT tests

Test ID	Moelcuar weight	Sample Mass	Temperature at the grate				Temperature 4 inches above the grate		Average CO_2	Average CO	Delta CO2	Delta CO
	g/gmole	Grams	T1	T2	T3	T5	T4	T6	ppmv			
Ambient air	28.9		16	19	17	17	19	17	437	0.00		
EX-PM Hot Blank-01-121511 (burner ON)	28.9	2177	830	748	826	144	120	672	1845	0	1408	0
EX-Hot blank-PM-01-121511	29	2178	830	748	826	144	120	672	1845	0	1408	0
EX-Hot Blank-PM2.5-01-121511	29	931	830	748	826	144	120	672	1845	0	1408	0
EX-Hot blank-MCE-01B-121511	28.8	188	830	748	826	144	120	672	1845	0	1408	0
EX-PM Air Blank-01-121511	28.8	1272										
EX-HT-PM-01-121511	29	1331										
EX-HT-PM2.5-01-121511	28.8	907										
EX-HT-MCE-01B-121511	28.8	380										
Ambient air									437	0		
EX-IMP LT Blank-01-021712	28.8	1404	153	117	437	191	116	117	732	0	295	0
EX-PM LT Blank-01-021712	28.8	1379	153	117	437	191	116	117	732	0	295	0
EX-PM2.5 LT Blank-01-021712	28.7	895	153	117	437	191	116	117	733	0	295	0
EX-MCE LT Blank-01-021712	28.8	606	153	117	438	191	116	117	733	0	295	0

Summary Sheet for HT tests

Test ID	CO$_2$ genrated from the burner	COgenerated from the burner	Mass of Carbon generated from the burner	
	ppmm		sampled	Total
Ambient air			grams	
EX-PM Hot Blank-01-121511 (burner ON)	2146	0.0	1.27	1309
EX-Hot blank-PM-01-121511	2146	0.0	1.27	1290
EX-Hot Blank-PM2.5-01-121511	2148	0.0	0.55	1307
EX-Hot blank-MCE-01B-121511	2148	0.0	0.11	1302
EX-PM Air Blank-01-121511				
EX-HT-PM-01-121511				
EX-HT-PM2.5-01-121511				
EX-HT-MCE-01B-121511				
Ambient air				
EX-IMP LT Blank-01-021712	450	0.0	0.17	300
EX-PM LT Blank-01-021712	450	0.0	0.17	300
EX-PM2.5 LT Blank-01-021712	453	0.0	0.11	301
EX-MCE LT Blank-01-021712	451	0.0	0.07	302

Summary Sheet for HT tests

Test ID	Sampling train Type	Start Time	End Time	Sample Volume	Total Flue gas Volume	Isokineticity
		EDT		Dry Standard Liters		
Air sampling		**10:00**	**10:15**			
Pre-Duff sampling		14:15	14:40			
EX-HT-IMP-01-121911	Impinger sampling Method for Asbestos	14:40	15:40	1192.2	2064330	97
EX-HT-PM-01-121911	Total PM sampling using EPA Method 5	14:40	15:40	1229.6	2053359	101
EX-HT-PM2.5-01-121911	PM 2.5 Sampling using EPA 201a	14:40	15:40	751.2	2069390	95
EX-HT-MCE-01A-121911	Asbestos Sampling using SOP-2015	14:40	14:15	76.6	515590	Non-Isokinetic sampling
EX-HT-MCE-01B-121911		14:56	15:11	75.6		
EX-HT-MCE-01C-121911		15:12	15:27	73.6		
EX-HT-MCE-01D-121911		15:28	15:43	75.6		
Air sampling		**9:13**	**9:28**			
Pre-Duff sampling		10:52	11:01			
EX-HT-IMP-02-122211	Impinger sampling Method for Asbestos	11:05	12:05	1126.9	1825560	106
EX-HT-PM-02-122211	Total PM sampling using EPA Method 5	11:05	12:05	1110.1	1831670	102
EX-HT-PM2.5-02-122211	PM 2.5 Sampling using EPA 201a	11:05	12:05	753.2	1828452	108
EX-HT-MCE-02A-122211	Asbestos Sampling using SOP-2015	11:05	11:20	74.9	457140	Non-Isokinetic sampling
EX-HT-MCE-02B-122211		11:21	11:36	78.9		
EX-HT-MCE-02C-122211		11:37	11:52	76.0		
EX-HT-MCE-02D-122211		11:53	12:08	82.6		
Air sampling		**8:49**	**9:15**			
Pre-Duff sampling		10:09	10:14			
EX-HT-IMP-03-122811	Impinger sampling Method for Asbestos	10:16	11:16	1038.5	1858606	99
EX-HT-PM-03-122811	Total PM sampling using EPA Method 5	10:16	11:16	1119.8	1876974	100
EX-HT-PM2.5-03-122811	PM 2.5 Sampling using EPA 201a	10:16	11:16	769.4	1861996	109
EX-HT-MCE-03A-122811	Asbestos Sampling using SOP-2015	10:16	10:31	48.4	466465	Non-Isokinetic sampling
EX-HT-MCE-03B-122811		10:34	10:49	75.6		
EX-HT-MCE-03C-122811		10:50	11:05	78.7		
EX-HT-MCE-03D-122811		11:06	11:21	70.8		

Summary Sheet for HT tests

Test ID	Molecular weight	Sample Mass	Temperature at the grate				Temperature 4 inches above the grate		Average CO_2
	g/gmole	Grams	T1	T2	T3	T5	T4	T6	
Air sampling			**8**	**8**	**5**	**8**	**8**	**8**	**437**
Pre-Duff sampling	28.8		712	791	919	493	562	442	1852
EX-HT-IMP-01-121911	28.8	1429	878	810	829	556	717	530	3717
EX-HT-PM-01-121911	28.8	1474	878	810	829	556	717	530	3717
EX-HT-PM2.5-01-121911	28.8	900	878	810	829	556	717	530	3717
EX-HT-MCE-01A-121911	28.8	92	899	858	852	578	684	568	3309
EX-HT-MCE-01B-121911		91	888	799	826	582	734	468	3648
EX-HT-MCE-01C-121911		88	846	782	820	592	718	556	3868
EX-HT-MCE-01D-121911		91	884	804	819	430	738	523	4074
Air sampling			**15**	**15**	**17**	**16**	**16**	**16**	
Pre-Duff sampling			785	746	772	393	572	496	1713
EX-HT-IMP-02-122211	28.8	1351	857	907	746	476	753	527	2381
EX-HT-PM-02-122211	28.8	1331	857	907	746	476	753	527	2381
EX-HT-PM2.5-02-122211	28.8	903	857	907	746	476	753	527	2381
EX-HT-MCE-02A-122211	28.8	90	845	931	700	542	726	560	2145
EX-HT-MCE-02B-122211		95	839	909	759	418	755	506	2328
EX-HT-MCE-02C-122211		91	858	901	763	449	764	520	2424
EX-HT-MCE-02D-122211		99	890	877	761	519	769	531	2692
Air sampling			**5**	**5**	**5**	**6**	**6**	**6**	
Pre-Duff sampling			659	756	939	546	804	484	1342
EX-HT-IMP-03-122811	28.8	1245	888	832	936	582	776	596	2674
EX-HT-PM-03-122811	28.8	1342	888	832	936	582	776	596	2674
EX-HT-PM2.5-03-122811	28.8	922	888	832	936	582	776	596	2674
EX-HT-MCE-03A-122811	28.8	58	955	851	974	606	818	615	2237
EX-HT-MCE-03B-122811		91	934	840	929	565	757	593	2548
EX-HT-MCE-03C-122811		94	846	833	953	578	768	588	2844
EX-HT-MCE-03D-122811		85	763	781	846	597	753	603	3236

Test ID	Average CO	Delta CO2	Delta CO	CO_2 genrated from the bu	COgenearated from the burn	Mass of Carbon generated from the burner or Duff	
	ppmv			ppmm		sampled	Total
Air sampling	**6**						
Pre-Duff sampling	7.50	1415	1	2159	1.2	0.00	
EX-HT-IMP-01-121911	75	1865	68	2845	65.8	1.15	1990
EX-HT-PM-01-121911	75	1865	68	2845	65.8	1.19	1980
EX-HT-PM2.5-01-121911	75	1865	68	2845	65.8	0.72	1995
EX-HT-MCE-01A-121911	37	1457	30	2223	28.9	0.057	382
EX-HT-MCE-01B-121911	70	1796	62	2740	60.4	0.070	478
EX-HT-MCE-01C-121911	96	2016	88	3076	85.9	0.077	541
EX-HT-MCE-01D-121911	95	2222	88	3390	85.2	0.087	594
Air sampling							
Pre-Duff sampling	0						
EX-HT-IMP-02-122211	58	667	57	1018	55.8	0.41	660
EX-HT-PM-02-122211	58	667	57	1018	55.8	0.40	662
EX-HT-PM2.5-02-122211	58	667	57	1018	55.8	0.27	661
EX-HT-MCE-02A-122211	21	431	21	658	20.3	0.017	103
EX-HT-MCE-02B-122211	46	615	46	938	44.8	0.026	151
EX-HT-MCE-02C-122211	74	710	74	1084	71.6	0.030	179
EX-HT-MCE-02D-122211	98	979	98	1493	95.0	0.044	246
Air sampling							
Pre-Duff sampling	0						
EX-HT-IMP-03-122811	61	1332	61	2033	59.2	0.72	1292
EX-HT-PM-03-122811	61	1332	61	2033	59.2	0.78	1305
EX-HT-PM2.5-03-122811	61	1332	61	2033	59.2	0.53	1294
EX-HT-MCE-03A-122811	11	895	11	1366	10.7	0.022	211
EX-HT-MCE-03B-122811	41	1207	41	1841	39.8	0.047	290
EX-HT-MCE-03C-122811	86	1502	86	2293	84.0	0.062	370
EX-HT-MCE-03D-122811	127	1894	128	2890	124.0	0.071	470

Test ID	Mass of Duff inserted	Mass of ash remaining	Mass loss using the scale
	Total	After 24 hours smoldering	During testing
Air sampling			
Pre-Duff sampling			
EX-HT-IMP-01-121911	5081	2379	NA
EX-HT-PM-01-121911			
EX-HT-PM2.5-01-121911			
EX-HT-MCE-01A-121911			
EX-HT-MCE-01B-121911			
EX-HT-MCE-01C-121911			
EX-HT-MCE-01D-121911			
Air sampling			
Pre-Duff sampling			
EX-HT-IMP-02-122211	5123	2397	2030
EX-HT-PM-02-122211			
EX-HT-PM2.5-02-122211			
EX-HT-MCE-02A-122211			
EX-HT-MCE-02B-122211			
EX-HT-MCE-02C-122211			
EX-HT-MCE-02D-122211			
Air sampling			
Pre-Duff sampling			
EX-HT-IMP-03-122811	5255	2329	2300
EX-HT-PM-03-122811			
EX-HT-PM2.5-03-122811			
EX-HT-MCE-03A-122811			
EX-HT-MCE-03B-122811			
EX-HT-MCE-03C-122811			
EX-HT-MCE-03D-122811			

Summary Sheet for LT tests

Test ID	Sampling train Type	Start Time	End Time	Sample Volume	Total Flue gas Volume	Isokinetic rate
		EDT		Dry Standard Liters		%
Ambient air		**10:55**	**11:05**			
Pre-Duff sampling (Torch Only)						
EX-LT-IMP-02-021412	Impinger sampling Method for Asbestos	11:05	12:05	1187.5	2134181	97
EX-LT-PM-03-021412	Total PM sampling using EPA Method 5	11:05	12:05	1187.4	2136481	99
EX-LT-PM2.5-03-021412	PM 2.5 Sampling using EPA 201a	11:05	12:05	745.0	2127280	92
EX-LT-MCE-03A-021412	Asbestos Sampling using SOP-2015	11:05	11:20	139.6	541173	106
EX-LT-MCE-03B-021412		11:21	11:36	127.8	533773	98
EX-LT-MCE-03C-021412		11:37	11:52	127.4	530347	98
EX-LT-MCE-03D-021412		11:54	12:09	126.1	528099	98
Ambient air		**9:01**	**9:03**			
Pre-Duff sampling (Torch Only)		10:50	11:10			
EX-LT-IMP-03-021512	Impinger sampling Method for Asbestos	11:10	12:10	1189.0	2094171	99
EX-LT-PM-03-021512	Total PM sampling using EPA Method 5	11:10	12:10	1167.3	2100541	99
EX-LT-PM2.5-03-021512	PM 2.5 Sampling using EPA 201a	11:10	12:10	753.7	2091134	95
EX-LT-MCE-03A-021512	Asbestos Sampling using SOP-2015	11:10	11:25	105.5	34377	81
EX-LT-MCE-03B-021512		11:28	11:43	132.0	43258	102
EX-LT-MCE-03C-021512		11:42	11:57	127.8	42227	99
EX-LT-MCE-03D-021512		11:58	12:13	127.7	42454	100
EX-LT-MCE-02E-021512		12:15	12:30	131.1	42339	100
Ambient air		**8:05**	**8:20**			
Pre-Duff sampling (Torch Only)		9:36	9:40			
EX-LT-IMP-03-021612	Impinger sampling Method for Asbestos	9:40	10:40	1136.9	2042326	97
EX-LT-PM-03-021612	Total PM sampling using EPA Method 5	9:40	10:40	1142.8	2047923	99
EX-LT-PM2.5-03-021612	PM 2.5 Sampling using EPA 201a	9:40	10:40	747.9	2041983	96
EX-LT-MCE-03A-021612	Asbestos Sampling using SOP-2015	9:40	9:55	127.0	518852	100
EX-LT-MCE-03B-021612		9:56	10:11	134.4	515172	107
EX-LT-MCE-03C-021612		10:13	10:28	124.3	513596	99
EX-LT-MCE-03D-021612		10:29	10:44	132.6	513650	106
EX-LT-MCE-03E-021612		10:46	11:01	131.1	523940	103

Summary Sheet for LT tests

Test ID	Moelcuar weight	Sample Mass	Temperature at the grate (°C)					
	g/gmole	Grams	T1	T2	T3	T4	T5	T6
Ambient air			**9**	**9**	**9**	**9**	**9**	**9**
Pre-Duff sampling (Torch Only)								
EX-LT-IMP-02-021412	28.8	1423	383	375	423	403	361	375
EX-LT-PM-03-021412	28.8	1423	383	375	423	403	361	375
EX-LT-PM2.5-03-021412	29.0	898	383	375	423	403	361	375
EX-LT-MCE-03A-021412	28.7	167	174	90	209	118	80	99
EX-LT-MCE-03B-021412	28.7	153	402	491	441	525	433	545
EX-LT-MCE-03C-021412	28.7	152	483	471	528	484	434	429
EX-LT-MCE-03D-021412	28.7	151	478	442	522	482	513	418
Ambient air			**6**	**7**	**7**	**7**	**7**	**7**
Pre-Duff sampling (Torch Only)			127	13	135	118	101	128
EX-LT-IMP-03-021512	28.8	1425	225		340	283	203	205
EX-LT-PM-03-021512	28.8	1399	225		340	283	203	205
EX-LT-PM2.5-03-021512	29.0	909	225		340	283	203	205
EX-LT-MCE-03A-021512	28.8	126	74	16	106	199	55	77
EX-LT-MCE-03B-021512	28.8	158	105	20	323	260	81	98
EX-LT-MCE-03C-021512	28.8	153	330	22	506	331	320	307
EX-LT-MCE-03D-021512	28.8	153	449	24	493	371	423	398
EX-LT-MCE-02E-021512	28.8	157	443	24	436	387	476	446
Ambient air			**8**	**8**	**8**	**8**	**8**	**8**
Pre-Duff sampling (Torch Only)			127	103	143	158	107	139
EX-LT-IMP-03-021612	28.8	1363	306	152	486	488	236	251
EX-LT-PM-03-021612	28.8	1370	306	152	486	488	236	251
EX-LT-PM2.5-03-021612	29.0	902	306	152	486	488	236	251
EX-LT-MCE-03A-021612	28.8	152	143	43	408	312	61	99
EX-LT-MCE-03B-021612	28.8	161	336	93	545	613	228	269
EX-LT-MCE-03C-021612	28.8	149	366	198	487	511	325	311
EX-LT-MCE-03D-021612	28.8	159	392	317	497	508	354	341
EX-LT-MCE-03E-021612	28.8	157	396	419	505	542	431	381

Test ID	**Duct Temperature Degree C**	**Average CO$_2$**	**Average CO**	**Delta CO2**	**Delta CO**	**CO$_2$ genrated from Duff**	**COgenearated from the Duff**	**Mass of Carbon genera**
		ppmv				**ppmm**		**sampled**
Ambient air	**9**	**426**	**10**					**grams**
Pre-Duff sampling (Torch Only)								
EX-LT-IMP-02-021412	33	888	28	The Torch emissions were not taken to determine the mass of carbon burned from Duff o				
EX-LT-PM-03-021412		888	28					
EX-LT-PM2.5-03-021412		888	28					
EX-LT-MCE-03A-021412	26	716	15					
EX-LT-MCE-03B-021412	31	775	20					
EX-LT-MCE-03C-021412	35	960	32					
EX-LT-MCE-03D-021412	38	1118	49					
Ambient air	**9**	**454**	**12**					
Pre-Duff sampling (Torch Only)	33	916	0					
EX-LT-IMP-03-021512	46	1542	41	626	41	956	39.8	0.40
EX-LT-PM-03-021512	46	1542	41	626	41	956	39.8	0.39
EX-LT-PM2.5-03-021512	46	1542	41	626	41	950	39.6	0.25
EX-LT-MCE-03A-021512	38	1055	2	139	2	212	2.0	0.01
EX-LT-MCE-03B-021512	44	1349	28	433	28	661	27.5	0.03
EX-LT-MCE-03C-021512	50	1854	66	939	66	1433	64.5	0.06
EX-LT-MCE-03D-021512	52	2103	83	1187	83	1811	80.8	0.08
EX-LT-MCE-02E-021512	28	869	68	415	55	633	53.9	0.03
Ambient air	**8**	**466**	**0**					
Pre-Duff sampling (Torch Only)	24	629	0					
EX-LT-IMP-03-021612	33	818	17	189	17	289	16.2	0.12
EX-LT-PM-03-021612	33	818	17	189	17	289	16.2	0.12
EX-LT-PM2.5-03-021612	33	818	17	189	17	287	16.1	0.08
EX-LT-MCE-03A-021612	28	681	3	52	2	79	2.3	0.003
EX-LT-MCE-03B-021612	31	799	14	170	14	259	13.3	0.012
EX-LT-MCE-03C-021612	35	927	22	298	21	455	20.9	0.020
EX-LT-MCE-03D-021612	37	857	32	228	32	348	30.7	0.017
EX-LT-MCE-03E-021612	19	530	19	64	19	98	18.5	0.005

Test ID	ted from the Duff	Mass of Duff inserted	Mass of ash remaining	Mass loss using the scale	Comments
	Total	Total	After 24 hours smoldering	During testing	
Ambient air					
Pre-Duff sampling (Torch Only)					
EX-LT-IMP-02-021412	nly	2542	1090	1210	NO CEM data for torch only
EX-LT-PM-03-021412					
EX-LT-PM2.5-03-021412					
EX-LT-MCE-03A-021412		636		310	
EX-LT-MCE-03B-021412		845		170	
EX-LT-MCE-03C-021412		641		290	
EX-LT-MCE-03D-021412		630		440	
Ambient air					
Pre-Duff sampling (Torch Only)					
EX-LT-IMP-03-021512	697	2485	917	1290	
EX-LT-PM-03-021512	699				
EX-LT-PM2.5-03-021512	696				
EX-LT-MCE-03A-021512	2	641		290	
EX-LT-MCE-03B-021512	10	630		390	
EX-LT-MCE-03C-021512	21	629		420	
EX-LT-MCE-03D-021512	27	585		190	
EX-LT-MCE-02E-021512	10	0		210	
Ambient air					
Pre-Duff sampling (Torch Only)					
EX-LT-IMP-03-021612	210	2568	1184	1420	
EX-LT-PM-03-021612	211				
EX-LT-PM2.5-03-021612	210				
EX-LT-MCE-03A-021612	14	640		330	Aborted sample, filter torn
EX-LT-MCE-03B-021612	47	643		450	
EX-LT-MCE-03C-021612	83	641		50	
EX-LT-MCE-03D-021612	67	644		590	
EX-LT-MCE-03E-021612	21	0		0	

APPENDIX C

Flue Gas Sampling Worksheets

US EPA

Burn Hut #1 Outlet Duct

RTP, NC

Asbestos Test Results

	RUN NUMBER	EX-HT-IMP-01-121911	EX-HT-IMP-02-122211	EX-HT-IMP-03-122811
	RUN DATE	12/19/2011	12/22/2011	12/28/2011
	RUN TIME	1440-1540	1105-1205	1016-1116
	MEASURED DATA			
(Y)	Meter Box Y	0.982	0.982	0.982
(DeltaH)	Avg Delta H, inches H2O	1.55	1.19	1.13
(Pbar)	Barometric Pressure, inches Hg	29.91	29.71	29.50
(Vm)	Meter Volume, ft^3	43.121	41.112	37.821
(Tm)	Avg Meter Temp, deg F	73	73	69
(Pg)	Static Pressure, inches H2O	-1.65	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	120	131	129
(Vlc)	Water Collected, mL	10.92	19.24	8.44
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.095	0.990	1.000
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.195	0.193	0.190
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.000207394	0.000203162	0.000196895
(Vmstd)	Standard Meter Volume, ft^3	42.102	39.795	36.673
(Ps)	Stack Pressure, inches Hg	29.79	29.59	29.38
(%H2O)	Moisture, %	1.2	2.2	1.1
(%H2Osat)	Moisture (at saturation), %	11.4	15.7	14.9
(Vwstd)	Standard Water Vapor Volume, ft^3	0.515	0.907	0.398
(Mfd)	Dry Mole Fraction	0.988	0.978	0.989
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.71	28.59	28.72
(Vs)	Velocity, ft/s	64.8	59.4	60.0
(A)	Stack Area, ft^2	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,356	1,244	1,256
(Qs)	Volumetric flow, dscfm	1,215	1,074	1,094
(I)	Isokinetic Rate, %	97.2	106.1	99.1

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:	Terll	Depth	0		
Run Number:	EX-HT-IMP-01-121911			Area Used	0.349066
Test Date:	12/19/2011				
Run Time:	1440-1540				

md=	28.84
Ps=	29.79
Mfd=	0.990
Ms=	28.73

K Factor Setup

Stack Temp.	100	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.91	<--input
Delta H@	1.66	<--input
Static Pressure	-1.65	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.201 <--CALCULATED

Actual Nozzle = 0.195 <--input

K Factor = 1.30 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.982 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	377.635	1.56	114	67	105.3	3.874	3.823	64.4	1.095	1.30
2	5	1.2	381.509	1.56	112	68	97.4	3.596	3.542	64.3	1.095	1.29
3	10	1.2	385.105	1.55	120	69	95.3	3.504	3.445	64.8	1.095	1.28
4	15	1.2	388.609	1.53	118	71	97.3	3.596	3.522	64.7	1.095	1.29
5	20	1.2	392.205	1.54	120	71	97.5	3.596	3.522	64.8	1.095	1.28
6	25	1.2	395.801	1.54	126	73	95.2	3.508	3.423	65.1	1.095	1.27
7	30	1.2	399.309	1.53	118	73	96.9	3.593	3.506	64.7	1.095	1.29
8	35	1.2	402.902	1.55	120	74	91.7	3.403	3.314	64.8	1.095	1.29
9	40	1.2	406.305	1.55	121	75	96.8	3.596	3.496	64.8	1.095	1.29
10	45	1.2	409.901	1.55	121	76	99.6	3.705	3.595	64.8	1.095	1.29
11	50	1.2	413.606	1.55	122	77	96.6	3.598	3.485	64.9	1.095	1.29
12	55	1.2	417.204	1.55	122	78	95.2	3.552	3.434	64.9	1.095	1.29
Stop	60/off		420.756									
	Averages-->	1.20		1.55	119.50	73	97.06	3.593		64.73	1.10	

TOTAL VOLUME = 43.121

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-HT-IMP-02-122211
Test Date: 12/22/2011
Run Time: 1105-1205

md= 28.84
Ps= 29.59
Mfd= 0.990
Ms= 28.73

K Factor Setup
Stack Temp. 120 <--input
Average Delta P 0.98 <--input
Meter Temp. 70 <--input
% Moisture 1 <--input
Sample Rate 0.75 <--input
Barometric Pres. 29.71 <--input
Delta H@ 1.66 <--input
Static Pressure -1.6 <--input
Pitot Coefficient 0.84 <--input
O2 % 20.9 <--input
CO2 % 0 <--input

Desired Nozzle = 0.209 <--CALCULATED

Actual Nozzle = 0.193 <--input

K Factor = 1.23 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.982 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	0.98	420.94	1.20	128	69	205.4	6.664	6.503	59.1	0.990	1.23
2	5	0.98	427.604	1.20	126	69	76.8	2.497	2.437	59.0	0.990	1.21
3	10	0.98	430.101	1.19	130	70	92.4	3.000	2.922	59.2	0.990	1.21
4	15	0.98	433.101	1.18	131	71	86.2	2.800	2.722	59.3	0.990	1.21
5	20	0.98	435.901	1.18	133	71	101.8	3.303	3.211	59.4	0.990	1.20
6	25	0.98	439.204	1.18	133	73	101.4	3.302	3.198	59.4	0.990	1.21
7	30	0.98	442.506	1.18	130	74	100.8	3.296	3.186	59.2	0.990	1.22
8	35	0.98	445.802	1.19	131	75	97.9	3.206	3.093	59.3	0.990	1.22
9	40	0.98	449.008	1.19	130	76	100.4	3.297	3.175	59.2	0.990	1.22
10	45	0.98	452.305	1.20	135	77	97.8	3.204	3.080	59.5	0.990	1.21
11	50	0.98	455.509	1.19	131	77	100.3	3.296	3.168	59.3	0.990	1.22
12	55	0.98	458.805	1.20	135	77	99.2	3.247	3.121	59.5	0.990	1.21
Stop	60		462.052									
	Averages-->	0.98		1.19	131.08	73	105.04	3.426		59.28	0.99	

TOTAL VOLUME = 41.112

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-HT-IMP-03-122811
Test Date:	12/28/2011
Run Time:	1016-1116

md=	28.84
Ps=	29.38
Mfd=	0.990
Ms=	28.73

K Factor Setup

Stack Temp.	130	<--input
Average Delta P	1	<--input
Meter Temp.	70	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.5	<--input
Delta H@	1.66	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input
Desired Nozzle =	0.208	<--CALCULATED
Actual Nozzle =	0.190	<--input
K Factor =	1.13	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.982	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1	462.189	1.13	123	63	92.1	2.917	2.858	59.7	1.000	1.13
2	5	1	465.106	1.13	121	63	82.0	2.599	2.547	59.6	1.000	1.14
3	10	1	467.705	1.14	122	63	91.6	2.904	2.845	59.6	1.000	1.13
4	15	1	470.609	1.13	124	64	104.1	3.299	3.226	59.7	1.000	1.13
5	20	1	473.908	1.13	124	65	100.7	3.197	3.121	59.7	1.000	1.13
6	25	1	477.105	1.13	128	68	103.6	3.297	3.200	59.9	1.000	1.13
7	30	1	480.402	1.13	129	69	100.6	3.206	3.106	60.0	1.000	1.13
8	35	1	483.608	1.13	129	70	103.3	3.297	3.188	60.0	1.000	1.14
9	40	1	486.905	1.14	129	72	106.1	3.400	3.275	60.0	1.000	1.14
10	45	1	490.305	1.14	130	74	93.3	2.997	2.876	60.0	1.000	1.14
11	50	1	493.302	1.14	143	75	106.9	3.403	3.260	60.7	1.000	1.12
12	55	1	496.705	1.12	145	76	103.8	3.305	3.160	60.8	1.000	1.12
Stop	60		500.01									
	Averages-->	1.00		1.13	128.92	69	99.01	3.152		59.98	1.00	

TOTAL VOLUME = 37.821

Distance from far wall to outside of port	36.25
Nipple length and/or wall thickness	10
Depth of stack or duct	26.25

% of depth	distance from inside wall	distance including nipple*
2.1	1.00	11.00
6.7	1.76	11.76
11.8	3.10	13.10
17.7	4.65	14.65
25	6.56	16.56
35.6	9.35	19.35
64.4	16.91	26.91
75	19.69	29.69
82.3	21.60	31.60
88.2	23.15	33.15
93.3	24.49	34.49
97.9	25.25	35.25

* mark these points on probe

EX-HT-M2-01.XLS

Burn Hut #1 Outlet Duct
VOLUMETRIC FLOW RATE TEST RESULTS

		PRE	POST	
	RUN NUMBER	EX-HT-M2-01-121911	EX-HT-M2-01-121911	
	RUN DATE	12/19/2011	12/19/2011	
	RUN TIME	1420	1555	
	MEASURED DATA			
(Pbar)	Barometric Pressure, inches Hg	29.91	29.91	
(Pg)	Static Pressure, inches H2O	-1.65	-1.65	
(Ts)	Avg Stack Temp, deg F	120	120	
(%CO2)	Carbon Dioxide, %	0.0	0.0	
(%O2)	Oxygen, %	20.9	20.9	
(%N2)	Nitrogen, %	79.1	79.1	
(Cp)	Pitot Tube Coefficient	0.84	0.84	% difference
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.08	1.08	0.0
	CALCULATED DATA			
(Ps)	Stack Pressure, inches Hg	29.79	29.79	
(%H2O)	Moisture, % *	1.5	1.5	
(Mfd)	Dry Mole Fraction	0.985	0.985	
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	
(Ms)	Molecular Weight-wet, lb/lb-mole	28.67	28.67	
(Vs)	Velocity, ft/s	63.9	63.9	
(A)	Stack Area, ft²	0.35	0.35	AVERAGE
(Qa)	Volumetric flow, acfm	1,342	1,342	1,342
(Qs)	Volumetric flow, dscfm	1,198	1,198	1,198

* average of isokinetic runs conducted.

EX-HT-M2-02.XLS

Burn Hut #1 Outlet Duct
VOLUMETRIC FLOW RATE TEST RESULTS

		PRE	POST	
	RUN NUMBER	EX-HT-M2-02-122211	EX-HT-M2-02-122211	
	RUN DATE	12/19/2011	12/19/2011	
	RUN TIME	1025	1222	
	MEASURED DATA			
(Pbar)	Barometric Pressure, inches Hg	29.71	29.71	
(Pg)	Static Pressure, inches H2O	-1.60	-1.65	
(Ts)	Avg Stack Temp, deg F	120	88	
(%CO2)	Carbon Dioxide, %	0.0	0.0	
(%O2)	Oxygen, %	20.9	20.9	
(%N2)	Nitrogen, %	79.1	79.1	
(Cp)	Pitot Tube Coefficient	0.84	0.84	% difference
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	0.99	0.96	3.1
	CALCULATED DATA			
(Ps)	Stack Pressure, inches Hg	29.59	29.59	
(%H2O)	Moisture, % *	1.5	1.5	
(Mfd)	Dry Mole Fraction	0.985	0.985	
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	
(Ms)	Molecular Weight-wet, lb/lb-mole	28.67	28.67	
(Vs)	Velocity, ft/s	58.8	55.4	
(A)	Stack Area, ft²	0.35	0.35	AVERAGE
(Qa)	Volumetric flow, acfm	1,234	1,164	1,199
(Qs)	Volumetric flow, dscfm	1,094	1,092	1,093

* average of isokinetic runs conducted.

EX-HT-M2-03.XLS

Burn Hut #1 Outlet Duct
VOLUMETRIC FLOW RATE TEST RESULTS

		PRE	POST	
	RUN NUMBER	EX-HT-M2-03-122811	EX-HT-M2-03-122811	
	RUN DATE	12/28/2011	12/28/2011	
	RUN TIME	0958	1125	
	MEASURED DATA			
(Pbar)	Barometric Pressure, inches Hg	29.50	29.50	
(Pg)	Static Pressure, inches H2O	-1.60	-1.65	
(Ts)	Avg Stack Temp, deg F	130	110	
(%CO2)	Carbon Dioxide, %	0.0	0.0	
(%O2)	Oxygen, %	20.9	20.9	
(%N2)	Nitrogen, %	79.1	79.1	
(Cp)	Pitot Tube Coefficient	0.84	0.84	% difference
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	0.99	1.00	-1.0
	CALCULATED DATA			
(Ps)	Stack Pressure, inches Hg	29.38	29.38	
(%H2O)	Moisture, % *	1.5	1.5	
(Mfd)	Dry Mole Fraction	0.985	0.985	
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	
(Ms)	Molecular Weight-wet, lb/lb-mole	28.67	28.67	
(Vs)	Velocity, ft/s	59.5	59.1	
(A)	Stack Area, ft²	0.35	0.35	AVERAGE
(Qa)	Volumetric flow, acfm	1,249	1,240	1,245
(Qs)	Volumetric flow, dscfm	1,081	1,111	1,096

* average of isokinetic runs conducted.

USEPA
Burn Hut #1 Exhaust Duct
RTP, NC
PM$_{2.5}$ Test Results

	RUN NUMBER	EX-HT-PM2.5-01-121911	EX-HT-PM2.5-02-122211	EX-HT-PM2.5-03-122811
	RUN DATE	12/19/2011	12/22/2011	12/28/2011
	RUN TIME	1440-1540	1105-1205	1016-1116
	MEASURED DATA			
(Y)	Meter Box Y	0.886	0.886	0.886
(DeltaH)	Avg Delta H, inches H2O	0.60	0.61	0.61
(Pbar)	Barometric Pressure, inches Hg	29.91	29.71	29.50
(Vm)	Meter Volume, ft^3	30.159	30.523	31.123
(Tm)	Avg Meter Temp, deg F	72	74	69
(Pg)	Static Pressure, inches H2O	-1.65	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	119	128	128
(Vlc)	Water Collected, mL	5.42	13.39	5.76
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.095	0.990	1.000
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.156	0.156	0.156
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.00013273	0.00013273	0.00013273
(Vmstd)	Standard Meter Volume, ft^3	26.527	26.598	27.171
(Ps)	Stack Pressure, inches Hg	29.79	29.59	29.38
(%H2O)	Moisture, %	1.0	2.3	1.0
(%H2Osat)	Moisture (at saturation), %	11.3	14.6	14.4
(Vwstd)	Standard Water Vapor Volume, ft^3	0.256	0.631	0.272
(Mfd)	Dry Mole Fraction	0.990	0.977	0.990
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.73	28.58	28.73
(Vs)	Velocity, ft/s	64.7	59.3	59.9
(A)	Stack Area, ft^2	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,355	1,242	1,255
(Qs)	Volumetric flow, dscfm	1,218	1,076	1,096
(I)	Isokinetic Rate, %	95.5	108.4	108.7
(vis)	Stack Gas Viscocity	192.2	193.4	194.2
(sf)	Sample Flow, acfm	0.49	0.51	0.52
(cpm10)	PM10 Cut Point, microns	9.91	9.74	9.68
(cpm2.5)	PM2.5 Cut Point, microns	2.43	2.24	2.26

(continued next page)

Burn Hut #1 Exhaust Duct

$PM_{2.5}$ Test Results

(continued)

	RUN NUMBER	EX-HT-PM2.5-01-121911	EX-HT-PM2.5-02-122211	EX-HT-PM2.5-03-122811
	RUN DATE	12/19/2011	12/22/2011	12/28/2011
	RUN TIME	1440-1540	1105-1205	1016-1116
	EMISSIONS DATA			
	FILTERABLE PARTICULATE $\leq$ 2.5um			
(mg)	Catch, milligrams	20.2	16.3	12.0
(gr/DSCF)	Concentration, gr/DSCF	0.0117	0.00946	0.00681
(mg/DSCM)	Concentration, mg/DSCM	26.9	21.6	15.6
(lb/hr)	Emission Rate, lb/hr	0.123	0.0872	0.0640
	FILTERABLE PARTICULATE > 2.5um			
(mg)	Catch, milligrams	3.7	5.7	5.9
(gr/DSCF)	Concentration, gr/DSCF	0.00215	0.00331	0.00335
(mg/DSCM)	Concentration, mg/DSCM	4.93	7.57	7.67
(lb/hr)	Emission Rate, lb/hr	0.0225	0.0305	0.0315
	TOTAL FILTERABLE PARTICULATE			
(mg)	Catch, milligrams	23.9	22.0	17.9
(gr/DSCF)	Concentration, gr/DSCF	0.0139	0.0128	0.0102
(mg/DSCM)	Concentration, mg/DSCM	31.8	29.2	23.3
(lb/hr)	Emission Rate, lb/hr	0.145	0.118	0.0955

BAROMETRIC PRESSURE, in. Hg = 29.91
STACK STATIC PRESSURE, in. H2O = -1.65
AVG. STACK TEMPERATURE, deg. F = 110
METER TEMPERATURE, deg. F 60
ORIFICE DELTA H@, in H20 = 1.77

%CO2 = 0
%O2 = 20.9
%N2+%CC 79.1
MOISTURE FRACTIC 0.01 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	110	160	60
DELTA H, IN H2O	0.595899	0.604832	0.588958

MW (DRY)	28.84		
MW (WET)	28.73		
PS=	29.78868		
VIS=	191.25	204.44	178.21
CYC FLOV	0.4813	0.5274	0.4365

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	60.43897	50.3007	42.97568	37.14156	33.35244	30.38931
MIN VEL ft/sec	44.06743	35.431	29.02434	23.73057	20.12246	17.12664
MAX VEL ft/sec	75.38326	63.46295	54.89356	48.10413	43.71654	40.30016
DEL. P MIN in. H2O	0.565496	0.365562	0.245312	0.163987	0.117912	0.085416
DEL. P MAX in. H2O	1.654795	1.172829	0.87748	0.673843	0.556526	0.472942

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.20	60.0	60.0	110
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	1.200	60.0		110

BAROMETRIC PRESSURE, in. Hg	=	29.71
STACK STATIC PRESSURE, in. H2O	=	-1.6
AVG. STACK TEMPERATURE, deg. F	=	120
METER TEMPERATURE, deg. F		70
ORIFICE DELTA H@, in H20	=	1.77
%CO2	=	0
%O2	=	20.9
%N2+%CC		79.1
MOISTURE FRACTIC		0.01 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	120	170	70
DELTA H, IN H2O	0.607442	0.616872	0.599939

MW (DRY)	28.84		
MW (WET)	28.73		
PS=	29.59235		
VIS=	193.87	207.10	180.81
CYC FLOW	0.4914	0.5379	0.4462

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	61.70423	51.35372	43.87536	37.9191	34.05066	31.0255
MIN VEL ft/sec	45.02303	36.21093	29.67605	24.27916	20.60378	17.55589
MAX VEL ft/sec	76.94141	64.77002	56.01992	49.08713	44.60682	41.11819
DEL. P MIN in. H2O	0.576287	0.372777	0.25037	0.167586	0.120688	0.087622
DEL. P MAX in. H2O	1.683022	1.192662	0.892184	0.685022	0.565681	0.480659

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	0.98	60.0	60.0	120
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	0.980	60.0		120

BAROMETRIC PRESSURE, in. Hg = 29.5
STACK STATIC PRESSURE, in. H2O = -1.6
AVG. STACK TEMPERATURE, deg. F = 130
METER TEMPERATURE, deg. F 70
ORIFICE DELTA H@, in H20 = 1.77
%CO2 = 0
%O2 = 20.9
%N2+%CC 79.1
MOISTURE FRACTIC 0.01 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	130	180	80
DELTA H, IN H2O	0.607395	0.617129	0.59949

MW (DRY)	28.84		
MW (WET	28.73		
PS=	29.38235		
VIS=	196.51	209.77	183.41
CYC FLOV	0.5016	0.5485	0.4561

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	62.99043	52.42417	44.78992	38.70951	34.76043	31.67221
MIN VEL ft/sec	45.9953	37.00473	30.33963	24.83804	21.09438	17.99363
MAX VEL ft/sec	78.52481	66.09814	57.16428	50.08574	45.51114	41.94905
DEL. P MIN in. H2O	0.587056	0.379985	0.255431	0.171193	0.123477	0.089844
DEL. P MAX in. H2O	1.711064	1.212358	0.90678	0.696115	0.574762	0.488311

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POIN 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.00	60.0	60.0	130
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	1.000	60.0		130

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	USEPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Exhaust Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:	JTN	Depth	0		
Run Number:	EX-HT-PM2.5-01-121911			Area Used	0.349066
Test Date:	12/19/2011				
Run Time:	1440-1540				

md= 28.84
Ps= 29.79

Mfd= 0.990
Ms= 28.73

Static Pressure = -1.65
Stack Temp = 110
Meter Temp = 60
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.91
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 1 ex: 1% = 1%

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1.2	414.674	0.60	114	69	92.7	2.436	2.156	64.4	1.095
2	5.0	1.2	417.11	0.60	113	69	96.2	2.530	2.239	64.4	1.095
3	5.0	1.2	419.64	0.60	120	70	95.9	2.510	2.217	64.8	1.095
4	5.0	1.2	422.15	0.60	120	71	96.1	2.520	2.222	64.8	1.095
5	5.0	1.2	424.67	0.60	120	71	96.8	2.540	2.239	64.8	1.095
6	5.0	1.2	427.21	0.60	126	72	96.4	2.520	2.218	65.1	1.095
7	5.0	1.2	429.73	0.60	118	73	95.5	2.520	2.213	64.7	1.095
8	5.0	1.2	432.25	0.60	118	73	95.5	2.520	2.213	64.7	1.095
9	5.0	1.2	434.77	0.60	116	74	94.8	2.510	2.200	64.5	1.095
10	5.0	1.2	437.28	0.60	120	74	95.5	2.520	2.209	64.8	1.095
11	5.0	1.2	439.8	0.60	122	75	95.5	2.520	2.205	64.9	1.095
12	5.0	1.2	442.32	0.60	122	76	95.1	2.513	2.195	64.9	1.095
			444.833								
	Averages-->	1.20		0.60	119.08	72.25	95.52			64.71	1.10

TOTAL VOLUME = 30.159

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:
Sampling Location:
City, State:
Operator's Initials:
Run Number: EX-HT-PM2.5-02-122211
Test Date: 12/22/2011
Run Time: 1105-1205

Stack Diameter (Rd): input
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> #VALUE!
Rec Area:=> 0.00
Area Used #VALUE!

Static Pressure = -1.6
Stack Temp = 120
Meter Temp = 70
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.71
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 1 ex: 1% = 1%

md= 28.84
Ps= 29.59

Mfd= 0.990
Ms= 28.73

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Average Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	0.98	445.256	0.61	125	71	104.9	2.484	2.175	59.0	0.990
2	5.0	0.98	447.74	0.61	125	71	108.1	2.560	2.242	59.0	0.990
3	5.0	0.98	450.3	0.61	126	72	107.1	2.540	2.220	59.0	0.990
4	5.0	0.98	452.84	0.61	131	72	108.4	2.560	2.238	59.3	0.990
5	5.0	0.98	455.4	0.61	128	73	107.1	2.540	2.216	59.1	0.990
6	5.0	0.98	457.94	0.61	130	73	106.9	2.530	2.207	59.2	0.990
7	5.0	0.98	460.47	0.61	130	74	107.1	2.540	2.212	59.2	0.990
8	5.0	0.98	463.01	0.61	129	74	106.6	2.530	2.203	59.2	0.990
9	5.0	0.98	465.54	0.61	128	75	107.1	2.550	2.217	59.1	0.990
10	5.0	0.98	468.09	0.61	129	76	107.5	2.560	2.221	59.2	0.990
11	5.0	0.98	470.65	0.61	129	76	107.5	2.560	2.221	59.2	0.990
12	5.0	0.98	473.21	0.61	130	77	107.7	2.569	2.225	59.2	0.990
Stop			475.779								
	Averages-->	0.98		0.61	128.33	73.67	107.17			59.14	0.99

TOTAL VOLUME = 30.523

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:		Stack Diameter (Rd):	input	Rd Area:=>	#VALUE!
Sampling Location:		Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:		Width	0		
Operator's Initials:		Depth	0		
Run Number:	EX-HT-PM2.5-03-122811			Area Used	#VALUE!
Test Date:	12/28/2011				
Run Time:	1016-1116				

Static Pressure = -1.6
Stack Temp = 130
Meter Temp = 70
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.5
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 1 ex: 1% = 1%

md= 28.84
Ps= 29.38

Mfd= 0.990
Ms= 28.73

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1	475.95	0.61	118	64	123.8	2.950	2.600	59.4	1.000
2	5.0	1	478.9	0.61	122	64	107.4	2.550	2.247	59.6	1.000
3	5.0	1	481.45	0.61	122	65	105.9	2.520	2.216	59.6	1.000
4	5.0	1	483.97	0.61	124	66	107.6	2.560	2.247	59.7	1.000
5	5.0	1	486.53	0.61	121	67	107.5	2.570	2.252	59.6	1.000
6	5.0	1	489.1	0.61	128	68	82.7	1.970	1.723	59.9	1.000
7	5.0	1	491.07	0.61	128	69	133.3	3.180	2.776	59.9	1.000
8	5.0	1	494.25	0.61	128	71	107.3	2.570	2.235	59.9	1.000
9	5.0	1	496.82	0.61	128	72	107.1	2.570	2.231	59.9	1.000
10	5.0	1	499.39	0.61	130	73	106.7	2.560	2.218	60.0	1.000
11	5.0	1	501.95	0.61	137	74	107.5	2.570	2.222	60.4	1.000
12	5.0	1	504.52	0.61	145	74	107.5	2.553	2.208	60.8	1.000
Stop			507.073								
	Averages-->	1.00		0.61	127.58	68.92	108.70			59.91	1.00

TOTAL VOLUME = 31.123

Distance from far wall to outside of port	37
Nipple length and/or wall thickness	6
Depth of stack or duct	31

% of depth	distance from inside wall	distance including nipple*
2.1	0.65	6.65
6.7	2.08	8.08
11.8	3.66	9.66
17.7	5.49	11.49
25	7.75	13.75
35.6	11.04	17.04
64.4	19.96	25.96
75	23.25	29.25
82.3	25.51	31.51
88.2	27.34	33.34
93.3	28.92	34.92
97.9	30.35	36.35

* mark these points on probe

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
Particulate Test Results

	RUN NUMBER	EX-HT-PM-01-121911	EX-HT-PM-02-122211	EX-HT-PM-03-122811
	RUN DATE	12/19/2011	12/22/2011	12/28/2011
	RUN TIME	1440-1540	1105-1205	1016-1116
	MEASURED DATA			
(Y)	Meter Box Y	0.986	0.986	0.986
(DeltaH)	Avg Delta H, inches H2O	1.56	1.25	1.27
(Pbar)	Barometric Pressure, inches Hg	29.91	29.71	29.50
(Vm)	Meter Volume, ft^3	43.459	39.554	39.905
(Tm)	Avg Meter Temp, deg F	63	63	59
(Pg)	Static Pressure, inches H2O	-1.65	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	119	128	128
(Vlc)	Water Collected, mL	17.80	17.90	0.00
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.095	0.990	1.000
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.195	0.195	0.195
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.000207394	0.000207394	0.000207394
(Vmstd)	Standard Meter Volume, ft^3	43.422	39.202	39.544
(Ps)	Stack Pressure, inches Hg	29.79	29.59	29.38
(%H2O)	Moisture, %	1.9	2.1	0.0
(%H2Osat)	Moisture (at saturation), %	11.3	14.6	14.4
(Vwstd)	Standard Water Vapor Volume, ft^3	0.839	0.844	0.000
(Mfd)	Dry Mole Fraction	0.981	0.979	1.000
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.63	28.61	28.84
(Vs)	Velocity, ft/s	64.8	59.3	59.8
(A)	Stack Area, ft^2	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,358	1,241	1,253
(Qs)	Volumetric flow, dscfm	1,209	1,078	1,105
(I)	Isokinetic Rate, %	100.8	102.0	100.4
	EMISSIONS DATA			
	Particulate			
(mg)	Catch, milligrams	24.5	10.3	13.2
(gr/DSCF)	Concentration, gr/DSCF	0.00871	0.00405	0.00515
(mg/DSCM)	Concentration, mg/DSCM	19.9	9.28	11.8
(lb/hr)	Emission Rate, lb/hr	0.0902	0.0375	0.0488

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:	JTN	Depth	0		
Run Number:	EX-HT-PM-01-121911			Area Used	0.349066
Test Date:	12/19/2011				
Run Time:	1440-1540				

md= 28.84
Ps= 29.79
Mfd= 0.990
Ms= 28.73

K Factor Setup

Stack Temp.	100	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.91	<--input
Delta H@	1.7	<--input
Static Pressure	-1.65	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.201 <--CALCULATED

Actual Nozzle = 0.195 <--input

K Factor = 1.33 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.986 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	550.32	1.60	114	59	100.6	3.630	3.653	64.4	1.095	1.33
2	5	1.2	553.95	1.60	113	59	103.0	3.720	3.743	64.4	1.095	1.30
3	10	1.2	557.67	1.56	120	60	102.3	3.680	3.696	64.8	1.095	1.28
4	15	1.2	561.35	1.54	120	61	102.4	3.690	3.698	64.8	1.095	1.29
5	20	1.2	565.04	1.54	120	62	101.3	3.660	3.661	64.8	1.095	1.29
6	25	1.2	568.7	1.55	126	63	100.5	3.620	3.614	65.1	1.095	1.28
7	30	1.2	572.32	1.53	118	64	99.4	3.610	3.598	64.7	1.095	1.30
8	35	1.2	575.93	1.56	118	64	98.0	3.560	3.548	64.7	1.095	1.30
9	40	1.2	579.49	1.56	116	64	96.8	3.520	3.508	64.5	1.095	1.30
10	45	1.2	583.01	1.56	120	64	100.7	3.650	3.638	64.8	1.095	1.29
11	50	1.2	586.66	1.55	122	66	98.0	3.560	3.534	64.9	1.095	1.30
12	55	1.2	590.22	1.55	122	66	98.0	3.559	3.533	64.9	1.095	1.30
Stop	60/off		593.779									
	Averages-->	1.20		1.56	119.08	63	100.07	3.622		64.71	1.10	

TOTAL VOLUME = 43.459

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-HT-PM-02-122211
Test Date:	12/22/2011
Run Time:	1105-1205

md=	28.84
Ps=	29.59
Mfd=	0.990
Ms=	28.73

K Factor Setup

Stack Temp.	120	<--input
Average Delta P	0.98	<--input
Meter Temp.	60	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.7	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.211	<--CALCULATED
Actual Nozzle =	0.195	<--input
K Factor =	1.28	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.986	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	0.98	593.887	1.26	125	60	103.1	3.353	3.342	59.0	0.990	1.28
2	5	0.98	597.24	1.26	125	60	103.4	3.360	3.349	59.0	0.990	1.27
3	10	0.98	600.6	1.25	126	60	102.8	3.340	3.329	59.0	0.990	1.27
4	15	0.98	603.94	1.25	131	62	102.3	3.320	3.297	59.3	0.990	1.27
5	20	0.98	607.26	1.24	128	62	101.1	3.290	3.267	59.1	0.990	1.27
6	25	0.98	610.55	1.25	130	63	100.4	3.270	3.241	59.2	0.990	1.27
7	30	0.98	613.82	1.25	130	63	100.1	3.260	3.231	59.2	0.990	1.27
8	35	0.98	617.08	1.25	129	64	100.2	3.270	3.235	59.2	0.990	1.28
9	40	0.98	620.35	1.25	128	65	100.8	3.300	3.258	59.1	0.990	1.28
10	45	0.98	623.65	1.25	129	65	99.7	3.260	3.219	59.2	0.990	1.28
11	50	0.98	626.91	1.25	129	66	98.6	3.230	3.183	59.2	0.990	1.28
12	55	0.98	630.14	1.25	130	66	100.8	3.301	3.253	59.2	0.990	1.28
Stop	60		633.441									
	Averages-->	0.98		1.25	128.33	63	101.10	3.296		59.14	0.99	

TOTAL VOLUME = 39.554

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-HT-PM-03-122811
Test Date:	12/28/2011
Run Time:	1016-1116

md=	28.84
Ps=	29.38
Mfd=	0.990
Ms=	28.73

K Factor Setup

Stack Temp.	130	<--input
Average Delta P	1	<--input
Meter Temp.	60	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.5	<--input
Delta H@	1.7	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input
Desired Nozzle =	0.210	<--CALCULATED
Actual Nozzle =	0.195	<--input
K Factor =	1.26	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.986	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1	634.035	1.26	118	53	109.3	3.575	3.587	59.4	1.000	1.26
2	5	1	637.61	1.26	122	54	105.3	3.440	3.445	59.6	1.000	1.27
3	10	1	641.05	1.27	122	55	101.5	3.320	3.318	59.6	1.000	1.27
4	15	1	644.37	1.27	124	56	95.3	3.120	3.112	59.7	1.000	1.27
5	20	1	647.49	1.27	121	58	104.7	3.450	3.428	59.6	1.000	1.28
6	25	1	650.94	1.28	128	60	101.9	3.350	3.316	59.9	1.000	1.27
7	30	1	654.29	1.27	128	60	99.2	3.260	3.227	59.9	1.000	1.27
8	35	1	657.55	1.27	128	61	100.5	3.310	3.270	59.9	1.000	1.27
9	40	1	660.86	1.27	128	63	98.6	3.260	3.208	59.9	1.000	1.27
10	45	1	664.12	1.27	130	64	98.6	3.260	3.202	60.0	1.000	1.27
11	50	1	667.38	1.27	137	64	98.9	3.250	3.192	60.4	1.000	1.26
12	55	1	670.63	1.26	146	65	101.3	3.310	3.245	60.8	1.000	1.24
Stop	60		673.94									
	Averages-->	1.00		1.27	127.67	59	101.26	3.325		59.92	1.00	

TOTAL VOLUME = 39.905

Distance from far wall to outside of port	8
Nipple length and/or wall thickness	0
Depth of stack or duct	8

% of depth	distance from inside wall	distance including nipple*		
4.4	1.00	1.00	0.8	
14.6	1.17	1.17	0.8	
29.6	2.37	2.37	0.9	
70.4	5.63	5.63	1.2	
85.4	6.83	6.83	1.2	
95.6	7.65	7.65	1.1	
			1.0	avg

* mark these points on probe

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
Asbestos Test Results

	RUN NUMBER	EX-IMP Hot Blank-01-121511	EX-IMP Hot Blank-02-122911	0
	RUN DATE	12/15/2011	12/29/2011	1/0/1900
	RUN TIME	1348-1448	1115-1215	0
	MEASURED DATA			
(Y)	Meter Box Y	0.982	0.982	0.000
(DeltaH)	Avg Delta H, inches H2O	3.79	1.13	#DIV/0!
(Pbar)	Barometric Pressure, inches Hg	30.20	29.68	0.00
(Vm)	Meter Volume, ft³	64.693	38.867	0.000
(Tm)	Avg Meter Temp, deg F	73	75	0
(Pg)	Static Pressure, inches H2O	-1.65	-1.60	0.00
(Ts)	Avg Stack Temp, deg F	135	129	#DIV/0!
(Vlc)	Water Collected, mL	21.10	9.01	0.00
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.000	0.995	0.000
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.250	0.190	0.000
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.000340885	0.000196895	0
(Vmstd)	Standard Meter Volume, ft³	64.083	37.467	#DIV/0!
(Ps)	Stack Pressure, inches Hg	30.08	29.56	0.00
(%H2O)	Moisture, %	1.5	1.1	#DIV/0!
(%H2Osat)	Moisture (at saturation), %	17.1	14.7	#DIV/0!
(Vwstd)	Standard Water Vapor Volume, ft³	0.995	0.425	0.000
(Mfd)	Dry Mole Fraction	0.985	0.989	#DIV/0!
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.67	28.71	#DIV/0!
(Vs)	Velocity, ft/s	59.6	59.5	#DIV/0!
(A)	Stack Area, ft²	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,249	1,246	#DIV/0!
(Qs)	Volumetric flow, dscfm	1,097	1,092	#DIV/0!
(I)	Isokinetic Rate, %	99.7	101.4	#DIV/0!

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:	Terll	Depth	0		
Run Number:	EX-IMP Hot Blank-01-121511			Area Used	0.349066
Test Date:	12/15/2011				
Run Time:	1348-1448				

md=	28.84
Ps=	30.08
Mfd=	0.990
Ms=	28.73

K Factor Setup

Stack Temp.	150	<--input
Average Delta P	1	<--input
Meter Temp.	70	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	30.2	<--input
Delta H@	1.66	<--input
Static Pressure	-1.65	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input
Desired Nozzle =	0.212	<--CALCULATED
Actual Nozzle =	0.250	<--input
K Factor =	3.29	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.982	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1	312.533	3.29	55	67	91.2	5.268	5.271	55.4	1.000	3.29
2	5	1	317.801	3.29	55	67	93.5	5.402	5.405	55.4	1.000	3.87
3	10	1	323.203	3.87	55	67	91.9	5.301	5.312	55.4	1.000	3.87
4	15	1	328.504	3.87	57	69	91.7	5.301	5.292	55.5	1.000	3.87
5	20	1	333.805	3.87	57	71	93.1	5.403	5.373	55.5	1.000	3.88
6	25	1	339.208	3.88	57	73	94.4	5.496	5.445	55.5	1.000	3.90
7	30	1	344.704	3.90	59	74	92.7	5.398	5.338	55.7	1.000	3.89
8	35	1	350.102	3.89	58	74	92.7	5.402	5.342	55.6	1.000	3.90
9	40	1	355.504	3.90	57	77	109.2	6.405	6.299	55.5	1.000	3.93
10	45	1	361.909	3.93	59	78	75.0	4.399	4.318	55.7	1.000	3.92
11	50	1	366.308	3.92	57	79	93.3	5.495	5.384	55.5	1.000	3.94
12	55	1	371.803	3.94	59	80	92.1	5.423	5.304	55.7	1.000	3.93
Stop	60/off		377.226									
	Averages-->	1.00		3.79	57.08	73	92.55	5.391		55.55	1.00	

TOTAL VOLUME = 64.693

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-IMP Hot Blank-02-122911
Test Date:	12/29/2011
Run Time:	1115-1215

md=	28.84
Ps=	29.56
Mfd=	0.990
Ms=	28.73

K Factor Setup

Stack Temp.	125	<--input
Average Delta P	0.99	<--input
Meter Temp.	60	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.68	<--input
Delta H@	1.66	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.211	<--CALCULATED
Actual Nozzle =	0.190	<--input
K Factor =	1.12	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.982	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	0.99	500.646	1.11	127	70	102.8	3.262	3.173	59.4	0.995	1.12
2	5	0.99	503.908	1.11	129	70	104.1	3.295	3.205	59.5	0.995	1.14
3	10	0.99	507.203	1.12	128	70	104.1	3.298	3.208	59.5	0.995	1.14
4	15	0.99	510.501	1.13	127	72	100.6	3.202	3.103	59.4	0.995	1.14
5	20	0.99	513.703	1.13	127	73	100.3	3.199	3.094	59.4	0.995	1.15
6	25	0.99	516.902	1.13	127	74	100.3	3.204	3.093	59.4	0.995	1.15
7	30	0.99	520.106	1.14	128	75	103.0	3.296	3.176	59.5	0.995	1.15
8	35	0.99	523.402	1.14	128	77	99.6	3.199	3.071	59.5	0.995	1.15
9	40	0.99	526.601	1.14	130	78	99.7	3.202	3.069	59.6	0.995	1.15
10	45	0.99	529.803	1.14	131	79	101.6	3.267	3.125	59.6	0.995	1.15
11	50	0.99	533.07	1.14	130	80	100.4	3.235	3.089	59.6	0.995	1.15
12	55	0.99	536.305	1.14	130	80	99.5	3.208	3.063	59.6	0.995	1.15
Stop	60/off		539.513									
	Averages-->	0.99		1.13	128.50	75	101.33	3.239		59.48	0.99	

TOTAL VOLUME = 38.867

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number:
Test Date:
Run Time:

md=	28.00
Ps=	0.00
Mfd=	1.000
Ms=	28.00

K Factor Setup

Stack Temp.		<--input
Average Delta P		<--input
Meter Temp.		<--input
% Moisture		<--input
Sample Rate	0.75	<--input
Barometric Pres.		<--input
Delta H@		<--input
Static Pressure		<--input
Pitot Coefficient	0.84	<--input
O2 %		<--input
CO2 %		<--input

Desired Nozzle =	#DIV/0!	<--CALCULATED
Actual Nozzle =		<--input
K Factor =	#DIV/0!	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =		<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0			#DIV/0!		0	#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
2	5			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
3	10			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
4	15			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
5	20			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
6	25			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
7	30			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
8	35			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
9	40			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
10	45			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
11	50			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
12	55			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
Stop	60/off											
	Averages-->	#DIV/0!		#DIV/0!	#DIV/0!	0	#DIV/0!	0.000		#DIV/0!	0.00	

TOTAL VOLUME = 0

Distance from far wall to outside of port	36.25
Nipple length and/or wall thickness	10
Depth of stack or duct	26.25

% of depth	distance from inside wall	distance including nipple*
2.1	1.00	11.00
6.7	1.76	11.76
11.8	3.10	13.10
17.7	4.65	14.65
25	6.56	16.56
35.6	9.35	19.35
64.4	16.91	26.91
75	19.69	29.69
82.3	21.60	31.60
88.2	23.15	33.15
93.3	24.49	34.49
97.9	25.25	35.25

* mark these points on probe

EX-M2 Hot Blank-01.XLS

Burn Hut #1 Outlet Duct
VOLUMETRIC FLOW RATE TEST RESULTS

		PRE	POST	
	RUN NUMBER	EX-M2 Hot Blank-01-121511	EX-M2 Hot Blank-01-121511	
	RUN DATE	12/15/2011	12/15/2011	
	RUN TIME	1315	1510	
	MEASURED DATA			
(Pbar)	Barometric Pressure, inches Hg	30.20	30.20	
(Pg)	Static Pressure, inches H2O	-1.65	-1.65	
(Ts)	Avg Stack Temp, deg F	140	135	
(%CO2)	Carbon Dioxide, %	0.0	0.0	
(%O2)	Oxygen, %	20.9	20.9	
(%N2)	Nitrogen, %	79.1	79.1	
(Cp)	Pitot Tube Coefficient	0.84	0.84	% difference
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.00	1.01	-1.0
	CALCULATED DATA			
(Ps)	Stack Pressure, inches Hg	30.08	30.08	
(%H2O)	Moisture, % *	1.5	1.5	
(Mfd)	Dry Mole Fraction	0.985	0.985	
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	
(Ms)	Molecular Weight-wet, lb/lb-mole	28.67	28.67	
(Vs)	Velocity, ft/s	59.9	60.2	
(A)	Stack Area, ft²	0.35	0.35	AVERAGE
(Qa)	Volumetric flow, acfm	1,258	1,265	1,261
(Qs)	Volumetric flow, dscfm	1,096	1,111	1,103

* average of isokinetic runs conducted.

EX-M2 Hot Blank-02.XLS

Burn Hut #1 Outlet Duct
VOLUMETRIC FLOW RATE TEST RESULTS

		PRE	POST	
	RUN NUMBER	EX-M2 Hot Blank-01-122911	EX-M2 Hot Blank-01-122911	
	RUN DATE	12/29/2011	12/29/2011	
	RUN TIME	1009	1225	
	MEASURED DATA			
(Pbar)	Barometric Pressure, inches Hg	29.68	29.68	
(Pg)	Static Pressure, inches H2O	-1.60	-1.65	
(Ts)	Avg Stack Temp, deg F	130	115	
(%CO2)	Carbon Dioxide, %	0.0	0.0	
(%O2)	Oxygen, %	20.9	20.9	
(%N2)	Nitrogen, %	79.1	79.1	
(Cp)	Pitot Tube Coefficient	0.84	0.84	% difference
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	0.99	1.00	-1.0
	CALCULATED DATA			
(Ps)	Stack Pressure, inches Hg	29.56	29.56	
(%H2O)	Moisture, % *	1.5	1.5	
(Mfd)	Dry Mole Fraction	0.985	0.985	
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	
(Ms)	Molecular Weight-wet, lb/lb-mole	28.67	28.67	
(Vs)	Velocity, ft/s	59.3	59.1	
(A)	Stack Area, ft²	0.35	0.35	AVERAGE
(Qa)	Volumetric flow, acfm	1,246	1,242	1,244
(Qs)	Volumetric flow, dscfm	1,084	1,109	1,097

* average of isokinetic runs conducted.

USEPA
Burn Hut #1 Exhaust Duct
RTP, NC
PM$_{2.5}$ Test Results

	RUN NUMBER	EX-PM2.5 Hot Blank-01-121511	EX-PM2.5 Hot Blank-02-122911	0
	RUN DATE	12/15/2011	12/29/2011	1/0/1900
	RUN TIME	1348-1448	1115-1215	0
	MEASURED DATA			
(Y)	Meter Box Y	0.886	0.886	0.000
(DeltaH)	Avg Delta H, inches H_2O	0.62	0.61	#NUM!
(Pbar)	Barometric Pressure, inches Hg	30.20	29.68	0.00
(Vm)	Meter Volume, ft^3	30.822	30.729	0.000
(Tm)	Avg Meter Temp, deg F	71	74	0
(Pg)	Static Pressure, inches H_2O	-1.65	-1.60	0.00
(Ts)	Avg Stack Temp, deg F	137	129	#DIV/0!
(Vlc)	Water Collected, mL	8.78	6.45	0.00
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H_2O)½	1.000	0.995	0.877
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.156	0.151	0.000
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.00013273	0.00012436	0.00000000
(Vmstd)	Standard Meter Volume, ft^3	27.438	26.713	#NUM!
(Ps)	Stack Pressure, inches Hg	30.08	29.56	0.00
(%H2O)	Moisture, %	1.5	1.1	#NUM!
(%H2Osat)	Moisture (at saturation), %	18.3	14.9	#DIV/0!
(Vwstd)	Standard Water Vapor Volume, ft^3	0.414	0.304	0.000
(Mfd)	Dry Mole Fraction	0.985	0.989	#NUM!
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.67	28.71	#NUM!
(Vs)	Velocity, ft/s	59.8	59.5	#DIV/0!
(A)	Stack Area, ft^2	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,252	1,247	#DIV/0!
(Qs)	Volumetric flow, dscfm	1,095	1,091	#DIV/0!
(I)	Isokinetic Rate, %	109.8	114.5	#DIV/0!
(vis)	Stack Gas Viscocity	196.3	194.5	#DIV/0!
(sf)	Sample Flow, acfm	0.52	0.51	#DIV/0!
(cpm10)	PM10 Cut Point, microns	9.69	9.82	#DIV/0!
(cpm2.5)	PM2.5 Cut Point, microns	2.43	2.24	2.26

(continued next page)

Burn Hut #1 Exhaust Duct

$PM_{2.5}$ Test Results

(continued)

	RUN NUMBER	-PM2.5 Hot Blank-01-121511	-PM2.5 Hot Blank-02-122911	0
	RUN DATE	12/15/2011	12/29/2011	1/0/1900
	RUN TIME	1348-1448	1115-1215	0
	EMISSIONS DATA			
	FILTERABLE PARTICULATE ≤ 2.5um			
(mg)	Catch, milligrams	0.0	0.0	0.0
(gr/DSCF)	Concentration, gr/DSCF	0.000000	0.000000	#NUM!
(mg/DSCM)	Concentration, mg/DSCM	0.00	0.00	#NUM!
(lb/hr)	Emission Rate, lb/hr	0.0000	0.0000	#NUM!
	FILTERABLE PARTICULATE > 2.5um			
(mg)	Catch, milligrams	10.0	0.0	0.0
(gr/DSCF)	Concentration, gr/DSCF	0.00562	0.00000	#NUM!
(mg/DSCM)	Concentration, mg/DSCM	12.87	0.00	#NUM!
(lb/hr)	Emission Rate, lb/hr	0.0528	0.0000	#NUM!
	TOTAL FILTERABLE PARTICULATE			
(mg)	Catch, milligrams	10.0	0.0	0.0
(gr/DSCF)	Concentration, gr/DSCF	0.00562	0.00000	#NUM!
(mg/DSCM)	Concentration, mg/DSCM	12.87	0.00	#NUM!
(lb/hr)	Emission Rate, lb/hr	0.053	0.000	#NUM!

BAROMETRIC PRESSURE, in. Hg = 30.2
STACK STATIC PRESSURE, in. H2O = -1.65
AVG. STACK TEMPERATURE, deg. F = 150
METER TEMPERATURE, deg. F 70
ORIFICE DELTA H@, in H20 = 1.77

%CO2 = 0
%O2 = 20.9
%N2+%CC 79.1
MOISTURE FRACTIC 0.01 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	150	200	100
DELTA H, IN H2O	0.616974	0.627429	0.6082

MW (DRY)	28.84		
MW (WET)	28.73		
PS=	30.07868		
VIS=	201.79	215.12	188.63
CYC FLOV	0.5166	0.5637	0.4709

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	64.874	53.99178	46.12925	39.86701	35.79985	32.61929
MIN VEL ft/sec	47.38483	38.1276	31.2657	25.60285	21.7507	18.56166
MAX VEL ft/sec	80.86432	68.0654	58.86383	51.57311	46.86134	43.19241
DEL. P MIN in. H2O	0.616915	0.399416	0.268586	0.180104	0.129985	0.094663
DEL. P MAX in. H2O	1.796638	1.272916	0.952015	0.730791	0.603359	0.51258

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.00	60.0	60.0	150
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	1.000	60.0		150

BAROMETRIC PRESSURE, in. Hg = 29.68
STACK STATIC PRESSURE, in. H2O = -1.6
AVG. STACK TEMPERATURE, deg. F = 125
METER TEMPERATURE, deg. F 70
ORIFICE DELTA H@, in H20 = 1.77
%CO2 = 0
%O2 = 20.9
%N2+%CC 79.1
MOISTURE FRACTIC 0.01 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.133	0.84	0.84
2	0.151	0.84	0.84
3	0.17	0.84	0.84
4	0.185	0.84	0.84
5	0.199	0.84	0.84
6	0.206	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	125	175	75
DELTA H, IN H2O	0.608051	0.617645	0.600335

MW (DRY)	28.84		
MW (WET	28.73		
PS=	29.56235		
VIS=	195.19	208.44	182.11
CYC FLO	0.4961	0.5427	0.4508

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.133	0.151	0.17	0.185	0.199	0.206
NOZZLE VEL ft/sec	85.70917	66.49311	52.46054	44.29831	38.28463	35.72697
MIN VEL ft/sec	64.93813	48.99342	37.10209	29.97981	24.53396	22.1277
MAX VEL ft/sec	105.3662	82.62234	66.10344	56.55076	49.55066	46.58593
DEL. P MIN in. H2O	1.18741	0.675891	0.387612	0.253081	0.169487	0.137871
DEL. P MAX in. H2O	3.126105	1.922189	1.230408	0.900488	0.691353	0.611098

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POIN 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	0.99	60.0	60.0	125
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL	0.990	60.0		125

BAROMETRIC PRESSURE, in. Hg =
STACK STATIC PRESSURE, in. H2O = -0.3
AVG. STACK TEMPERATURE, deg. F = 170
METER TEMPERATURE, deg. F 95
ORIFICE DELTA H@, in H20 =
%CO2 = 2
%O2 = 17
%N2+%CC 81
MOISTURE FRACTIC 0.1 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0	0.84	0.84
2	0	0.84	0.84
3	0	0.84	0.84
4	0	0.84	0.84
5	0	0.84	0.84
6	0	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	170	220	120
DELTA H, IN H2O	#NUM!	#NUM!	#NUM!

MW (DRY)	29.00		
MW (WET	27.90		
PS=	-0.02206		
VIS=	198.36	211.75	185.13
CYC FLOV	#NUM!	#NUM!	#NUM!

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0	0	0	0	0	0
NOZZLE VEL ft/sec	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
MIN VEL ft/sec	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
MAX VEL ft/sec	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
DEL. P MIN in. H2O	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
DEL. P MAX in. H2O	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	0.77	60.0	60.0	170
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	0.770	60.0		170

Blue = Input Items
Red = Calculated/Protected Items

Facility Name: USEPA
Sampling Location: Burn Hut #1 Exhaust Duct
City, State: RTP, NC
Operator's Initials:
Run Number: EX-PM2.5 Hot Blank-01-121511
Test Date: 12/15/2011
Run Time: 1348-1448

Stack Diameter (Rd): 8
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> 0.35
Rec Area:=> 0.00
Area Used 0.349066

Static Pressure = -1.65
Stack Temp = 150
Meter Temp = 70
CO2 = 0
O2 = 20.9
Barometric Pres. = 30.2
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 1 ex: 1% = 1%

md= 28.84
Ps= 30.08

Mfd= 0.990
Ms= 28.73

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1	383.61	0.62	133	69	129.1	3.030	2.708	59.5	1.000
2	5.0	1	386.64	0.62	136	69	105.9	2.480	2.216	59.6	1.000
3	5.0	1	389.12	0.62	135	69	113.5	2.660	2.377	59.6	1.000
4	5.0	1	391.78	0.62	135	71	104.1	2.450	2.181	59.6	1.000
5	5.0	1	394.23	0.62	140	70	108.2	2.530	2.257	59.8	1.000
6	5.0	1	396.76	0.62	140	70	109.0	2.550	2.274	59.8	1.000
7	5.0	1	399.31	0.62	136	71	108.5	2.550	2.270	59.6	1.000
8	5.0	1	401.86	0.62	138	72	108.0	2.540	2.257	59.7	1.000
9	5.0	1	404.4	0.62	138	72	108.5	2.550	2.266	59.7	1.000
10	5.0	1	406.95	0.62	138	73	109.1	2.570	2.279	59.7	1.000
11	5.0	1	409.52	0.62	140	73	108.9	2.560	2.270	59.8	1.000
12	5.0	1	412.08	0.62	140	73	100.0	2.352	2.086	59.8	1.000
			414.432								
Averages-->		1.00		0.62	137.42	71.00	109.40			59.71	1.00

TOTAL VOLUME = 30.822

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:
Sampling Location:
City, State:
Operator's Initials:
Run Number: EX-PM2.5 Hot Blank-02-122911
Test Date: 12/29/2011
Run Time: 1115-1215

Stack Diameter (Rd): input
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> #VALUE!
Rec Area:=> 0.00
Area Used #VALUE!

md= 28.84
Ps= 29.56

Mfd= 0.990
Ms= 28.73

Static Pressure = -1.6
Stack Temp = 125
Meter Temp = 70
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.68
Pitot Coefficient = 0.84
Actual Nozzle = 0.151
Meter Box Gamma = 0.886
Moisture % = 1 ex: 1% = 1%

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Average Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	0.99	507.177	0.61	130	71	113.6	2.523	2.207	59.6	0.995
2	5.0	0.99	509.7	0.61	128	71	116.8	2.600	2.275	59.5	0.995
3	5.0	0.99	512.3	0.61	128	71	116.4	2.590	2.266	59.5	0.995
4	5.0	0.99	514.89	0.61	127	72	114.7	2.560	2.236	59.4	0.995
5	5.0	0.99	517.45	0.61	126	73	114.4	2.560	2.231	59.4	0.995
6	5.0	0.99	520.01	0.61	127	74	114.3	2.560	2.227	59.4	0.995
7	5.0	0.99	522.57	0.61	130	75	113.9	2.550	2.214	59.6	0.995
8	5.0	0.99	525.12	0.61	129	76	114.1	2.560	2.219	59.5	0.995
9	5.0	0.99	527.68	0.61	130	76	114.2	2.560	2.219	59.6	0.995
10	5.0	0.99	530.24	0.61	129	77	113.4	2.550	2.206	59.5	0.995
11	5.0	0.99	532.79	0.61	132	78	113.5	2.550	2.202	59.7	0.995
12	5.0	0.99	535.34	0.61	132	79	114.0	2.566	2.212	59.7	0.995
Stop	60.0		537.906								
	Averages-->	0.99		0.61	129.00	74.42	114.43			59.50	0.99

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:
Sampling Location:
City, State:
Operator's Initials:
Run Number:
Test Date:
Run Time:

Stack Diameter (Rd): input
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> #VALUE!
Rec Area:=> 0.00
Area Used #VALUE!

Static Pressure =
Stack Temp =
Meter Temp =
CO2 =
O2 =
Barometric Pres. =
Pitot Coefficient = 0.84
Actual Nozzle =
Meter Box Gamma =
Moisture % = 1 ex: 1% = 1%

md= 28.00
Ps= 0.00

Mfd= 0.990
Ms= 27.90

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	0.0	0.77		#NUM!		0	#NUM!	0.000	#NUM!	#DIV/0!	0.877
2	5.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
3	10.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
4	15.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
5	20.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
6	25.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
7	30.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
8	35.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
9	40.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
10	45.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
11	50.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
12	55.0	0.77		#NUM!			#NUM!	0.000	#NUM!	#DIV/0!	0.877
Stop	60.0										
	Averages-->	0.77		#NUM!	#DIV/0!	0.00	#NUM!			#DIV/0!	0.88

Distance from far wall to outside of port	37
Nipple length and/or wall thickness	6
Depth of stack or duct	31

% of depth	distance from inside wall	distance including nipple*
2.1	0.65	6.65
6.7	2.08	8.08
11.8	3.66	9.66
17.7	5.49	11.49
25	7.75	13.75
35.6	11.04	17.04
64.4	19.96	25.96
75	23.25	29.25
82.3	25.51	31.51
88.2	27.34	33.34
93.3	28.92	34.92
97.9	30.35	36.35

* mark these points on probe

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
Particulate Test Results

	RUN NUMBER	EX-PM Hot Blank-01-121511	EX-PM Hot Blank-02-122911	0
	RUN DATE	12/15/2011	12/29/2011	1/0/1900
	RUN TIME	1348-1448	1115-1215	0
	MEASURED DATA			
(Y)	Meter Box Y	0.987	0.986	0.000
(DeltaH)	Avg Delta H, inches H2O	3.65	1.26	#DIV/0!
(Pbar)	Barometric Pressure, inches Hg	30.20	29.68	0.00
(Vm)	Meter Volume, ft^3	64.609	39.788	0.000
(Tm)	Avg Meter Temp, deg F	74	65	0
(Pg)	Static Pressure, inches H2O	-1.65	-1.60	0.00
(Ts)	Avg Stack Temp, deg F	137	129	#DIV/0!
(Vlc)	Water Collected, mL	40.64	8.03	0.00
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.000	0.995	0.000
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.250	0.195	0.000
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.000340885	0.000207394	0
(Vmstd)	Standard Meter Volume, ft^3	64.162	39.214	#DIV/0!
(Ps)	Stack Pressure, inches Hg	30.08	29.56	0.00
(%H2O)	Moisture, %	2.9	1.0	#DIV/0!
(%H2Osat)	Moisture (at saturation), %	18.3	14.9	#DIV/0!
(Vwstd)	Standard Water Vapor Volume, ft^3	1.916	0.379	0.000
(Mfd)	Dry Mole Fraction	0.971	0.990	#DIV/0!
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.52	28.73	#DIV/0!
(Vs)	Velocity, ft/s	59.9	59.5	#DIV/0!
(A)	Stack Area, ft^2	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,255	1,246	#DIV/0!
(Qs)	Volumetric flow, dscfm	1,082	1,093	#DIV/0!
(I)	Isokinetic Rate, %	101.2	100.7	#DIV/0!
	EMISSIONS DATA			
	Particulate			
(mg)	Catch, milligrams	0.00	0.00	0.000
(gr/DSCF)	Concentration, gr/DSCF	0.00000	0.00000	#DIV/0!
(mg/DSCM)	Concentration, mg/DSCM	-	-	#DIV/0!
(lb/hr)	Emission Rate, lb/hr	0.000	0.000	#DIV/0!

Blue = Input Items
Red = Calculated/Protected Items

Facility Name: US EPA
Sampling Location: Burn Hut #1 Outlet Duct
City, State: RTP, NC
Operator's Initials:
Run Number: EX-PM Hot Blank-01-121511
Test Date: 12/15/2011
Run Time: 1348-1448

Stack Diameter (Rd): 8
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> 0.35
Rec Area:=> 0.00
Area Used 0.349066

md= 28.84
Ps= 30.08
Mfd= 0.990
Ms= 28.73

K Factor Setup

Stack Temp.	150	<--input
Average Delta P	1	<--input
Meter Temp.	70	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	30.2	<--input
Delta H@	1.8	<--input
Static Pressure	-1.65	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.212 <--CALCULATED

Actual Nozzle = 0.250 <--input

K Factor = 3.56 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.987 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1	209.177	3.56	133	70	111.9	6.023	6.027	59.5	1.000	3.56
2	5	1	215.2	3.56	136	70	100.2	5.380	5.384	59.6	1.000	3.64
3	10	1	220.58	3.64	135	70	100.3	5.390	5.395	59.6	1.000	3.65
4	15	1	225.97	3.65	135	70	98.4	5.290	5.295	59.6	1.000	3.65
5	20	1	231.26	3.65	140	70	97.2	5.200	5.205	59.8	1.000	3.62
6	25	1	236.46	3.62	140	72	97.5	5.240	5.225	59.8	1.000	3.63
7	30	1	241.7	3.63	136	74	97.2	5.260	5.225	59.6	1.000	3.67
8	35	1	246.96	3.67	138	76	96.3	5.220	5.166	59.7	1.000	3.67
9	40	1	252.18	3.67	138	78	100.7	5.480	5.404	59.7	1.000	3.69
10	45	1	257.66	3.69	138	79	100.2	5.460	5.374	59.7	1.000	3.69
11	50	1	263.12	3.69	140	80	101.8	5.550	5.453	59.8	1.000	3.69
12	55	1	268.67	3.69	140	81	93.7	5.116	5.017	59.8	1.000	3.70
Stop	60/off		273.786									
Averages-->		1.00		3.65	137.42	74	99.61	5.384		59.71	1.00	

TOTAL VOLUME = 64.609

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-PM Hot Blank-02-122911
Test Date:	12/29/2011
Run Time:	1115-1215

md=	28.84
Ps=	29.56
Mfd=	0.990
Ms=	28.73

K Factor Setup

Stack Temp.	125	<--input
Average Delta P	0.99	<--input
Meter Temp.	55	<--input
% Moisture	1	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.68	<--input
Delta H@	1.7	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input
Desired Nozzle =	0.212	<--CALCULATED
Actual Nozzle =	0.195	<--input
K Factor =	1.26	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.986	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	0.99	674.075	1.25	130	61	99.5	3.245	3.225	59.6	0.995	1.26
2	5	0.99	677.32	1.25	128	62	102.6	3.360	3.333	59.5	0.995	1.27
3	10	0.99	680.68	1.26	128	62	103.0	3.370	3.343	59.5	0.995	1.27
4	15	0.99	684.05	1.26	127	63	101.1	3.320	3.287	59.4	0.995	1.28
5	20	0.99	687.37	1.26	127	64	101.0	3.320	3.281	59.4	0.995	1.28
6	25	0.99	690.69	1.27	127	65	101.7	3.350	3.304	59.4	0.995	1.28
7	30	0.99	694.04	1.27	130	66	100.5	3.310	3.259	59.6	0.995	1.28
8	35	0.99	697.35	1.26	129	67	100.6	3.320	3.262	59.5	0.995	1.28
9	40	0.99	700.67	1.27	130	68	99.5	3.290	3.227	59.6	0.995	1.28
10	45	0.99	703.96	1.27	129	68	100.4	3.320	3.256	59.5	0.995	1.28
11	50	0.99	707.28	1.27	132	69	99.8	3.300	3.230	59.7	0.995	1.28
12	55	0.99	710.58	1.27	132	70	99.1	3.283	3.208	59.7	0.995	1.28
Stop	60/off		713.863									
	Averages-->	0.99		1.26	129.08	65	100.73	3.316		59.51	0.99	

TOTAL VOLUME = 39.788

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number:
Test Date:
Run Time:

md=	28.00
Ps=	0.00
Mfd=	1.000
Ms=	28.00

K Factor Setup

Stack Temp.		<--input
Average Delta P		<--input
Meter Temp.		<--input
% Moisture		<--input
Sample Rate	0.75	<--input
Barometric Pres.		<--input
Delta H@		<--input
Static Pressure		<--input
Pitot Coefficient	0.84	<--input
O2 %		<--input
CO2 %		<--input

Desired Nozzle = #DIV/0! <--CALCULATED

Actual Nozzle = <--input

K Factor = #DIV/0! <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0			#DIV/0!		0	#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
2	5			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
3	10			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
4	15			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
5	20			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
6	25			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
7	30			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
8	35			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
9	40			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
10	45			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
11	50			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
12	55			#DIV/0!			#DIV/0!	0.000	#DIV/0!	#DIV/0!	0.000	#DIV/0!
Stop	60/off											
	Averages-->	#DIV/0!		#DIV/0!	#DIV/0!	0	#DIV/0!	0.000		#DIV/0!	0.00	

TOTAL VOLUME = 0

Distance from far wall to outside of port	8
Nipple length and/or wall thickness	0
Depth of stack or duct	8

% of depth	distance from inside wall	distance including nipple*		
4.4	1.00	1.00	0.8	
14.6	1.17	1.17	0.8	
29.6	2.37	2.37	0.9	
70.4	5.63	5.63	1.2	
85.4	6.83	6.83	1.2	
95.6	7.65	7.65	1.1	
			1.0	avg

* mark these points on probe

US EPA

Burn Hut #1 Outlet Duct

RTP, NC

Asbestos Test Results

	RUN NUMBER	EX-LT-IMP-01-021312
	RUN DATE	2/13/2012
	RUN TIME	0
	MEASURED DATA	
(Y)	Meter Box Y	0.982
(DeltaH)	Avg Delta H, inches H2O	1.41
(Pbar)	Barometric Pressure, inches Hg	29.85
(Vm)	Meter Volume, ft³	41.316
(Tm)	Avg Meter Temp, deg F	73
(Pg)	Static Pressure, inches H2O	-1.60
(Ts)	Avg Stack Temp, deg F	73
(Vlc)	Water Collected, mL	3.76
(%CO2)	Carbon Dioxide, %	0.0
(%O2)	Oxygen, %	20.9
(%N2)	Nitrogen, %	79.1
(Cp)	Pitot Tube Coefficient	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.049
(Theta)	Sample Time, min	60.0
(Dn)	Nozzle Diameter, inches	0.192
	CALCULATED DATA	
(An)	Nozzle Area, square feet	0.000201062
(Vmstd)	Standard Meter Volume, ft³	40.258
(Ps)	Stack Pressure, inches Hg	29.73
(%H2O)	Moisture, %	0.4
(%H2Osat)	Moisture (at saturation), %	2.8
(Vwstd)	Standard Water Vapor Volume, ft³	0.177
(Mfd)	Dry Mole Fraction	0.996
(Md)	Molecular Weight-dry, lb/lb-mole	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.79
(Vs)	Velocity, ft/s	59.4
(A)	Stack Area, ft²	0.35
(Qa)	Volumetric flow, acfm	1,245
(Qs)	Volumetric flow, dscfm	1,219
(I)	Isokinetic Rate, %	95.6
	EMISSIONS DATA	
	Particulate	
(mg)	Catch, milligrams	4.10
(gr/DSCF)	Concentration, gr/DSCF	0.00157
(mg/DSCM)	Concentration, mg/DSCM	3.60
(lb/hr)	Emission Rate, lb/hr	0.016

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:		Depth	0		
Run Number:	EX-LT-IMP-01-021312			Area Used	0.349066
Test Date:	2/13/2012				
Run Time:					

md=	28.84
Ps=	29.73
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.1	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.85	<--input
Delta H@	1.66	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.203 <--CALCULATED

Actual Nozzle = 0.192 <--input

K Factor = 1.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.982 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	539.61	1.37	53	81	97.7	3.599	3.451	58.5	1.049	1.25
2	5	1.1	543.209	1.37	54	65	97.8	3.494	3.453	58.5	1.049	1.32
3	10	1.1	546.703	1.45	56	66	100.8	3.600	3.552	58.7	1.049	1.32
4	15	1.1	550.303	1.45	57	67	98.0	3.503	3.449	58.7	1.049	1.32
5	20	1.1	553.806	1.45	75	75	92.4	3.295	3.196	59.7	1.049	1.29
6	25	1.1	557.101	1.42	81	70	99.7	3.504	3.431	60.1	1.049	1.27
7	30	1.1	560.605	1.39	81	72	93.6	3.303	3.221	60.1	1.049	1.27
8	35	1.1	563.908	1.40	83	72	96.5	3.399	3.315	60.2	1.049	1.27
9	40	1.1	567.307	1.39	88	74	102.2	3.595	3.493	60.4	1.049	1.26
10	45	1.1	570.902	1.39	84	75	90.5	3.203	3.106	60.2	1.049	1.27
11	50	1.1	574.105	1.40	83	76	95.7	3.397	3.288	60.2	1.049	1.28
12	55	1.1	577.502	1.41	83	77	96.3	3.424	3.308	60.2	1.049	1.28
Stop	60/off		580.926									
	Averages-->	1.10		1.41	73.17	73	96.77	3.443		59.61	1.05	

TOTAL VOLUME = 41.316

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-IMP-02-021412
Test Date: 2/14/2012
Run Time:

md=	28.84
Ps=	29.59
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.1	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.66	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.203 <--CALCULATED

Actual Nozzle = 0.192 <--input

K Factor = 1.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.982 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.25
2	5			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
3	10			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
4	15			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
5	20			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
6	25			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
7	30			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
8	35			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
9	40			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
10	45			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
11	50			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
12	55			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
Stop	60/off											
	Averages-->	#DIV/0!		0.00	#DIV/0!	#DIV/0!	#DIV/0!	0.000		0.00	0.00	

TOTAL VOLUME = 0

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-IMP-03-0215612
Test Date:	2/15/2012
Run Time:	

md= 28.84
Ps= 29.68
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.66	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.199 <--CALCULATED

Actual Nozzle = 0.192 <--input

K Factor = 1.26 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.982 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.26
2	5			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
3	10			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
4	15			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
5	20			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
6	25			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
7	30			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
8	35			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
9	40			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
10	45			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
11	50			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
12	55			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.29
Stop	60/off											
	Averages-->	#DIV/0!		0.00	#DIV/0!	#DIV/0!	#DIV/0!	0.000		0.00	0.00	

TOTAL VOLUME = 0

Distance from far wall to outside of port	36.25
Nipple length and/or wall thickness	10
Depth of stack or duct	26.25

% of depth	distance from inside wall	distance including nipple*
2.1	1.00	11.00
6.7	1.76	11.76
11.8	3.10	13.10
17.7	4.65	14.65
25	6.56	16.56
35.6	9.35	19.35
64.4	16.91	26.91
75	19.69	29.69
82.3	21.60	31.60
88.2	23.15	33.15
93.3	24.49	34.49
97.9	25.25	35.25

* mark these points on probe

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
Asbestos Test Results

	RUN NUMBER	EX-LT-IMP-02-021412	EX-LT-IMP-03-021512	EX-LT-IMP-04-021612
	RUN DATE	2/14/2012	2/15/2012	2/16/2012
	RUN TIME	1105-1205	1110-1210	0940-1040
	MEASURED DATA			
(Y)	Meter Box Y	0.982	0.982	0.982
(DeltaH)	Avg Delta H, inches H2O	1.51	1.47	1.39
(Pbar)	Barometric Pressure, inches Hg	29.71	29.80	29.83
(Vm)	Meter Volume, ft^3	42.958	42.826	40.949
(Tm)	Avg Meter Temp, deg F	69	68	69
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	80	102	83
(Vlc)	Water Collected, mL	9.20	10.16	8.86
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.095	1.095	1.049
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.192	0.192	0.192
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.000201062	0.000201062	0.000201062
(Vmstd)	Standard Meter Volume, ft^3	41.936	41.988	40.148
(Ps)	Stack Pressure, inches Hg	29.59	29.68	29.71
(%H2O)	Moisture, %	1.0	1.1	1.0
(%H2Osat)	Moisture (at saturation), %	3.5	6.9	3.8
(Vwstd)	Standard Water Vapor Volume, ft^3	0.434	0.479	0.418
(Mfd)	Dry Mole Fraction	0.990	0.989	0.990
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.73	28.71	28.72
(Vs)	Velocity, ft/s	62.7	63.9	60.1
(A)	Stack Area, ft^2	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,313	1,338	1,258
(Qs)	Volumetric flow, dscfm	1,256	1,233	1,202
(I)	Isokinetic Rate, %	96.6	98.6	96.7
	EMISSIONS DATA			
	Particulate			
(mg)	Catch, milligrams	0.00	0.00	0.000
(gr/DSCF)	Concentration, gr/DSCF	0.00000	0.00000	0.00000
(mg/DSCM)	Concentration, mg/DSCM	-	-	-
(lb/hr)	Emission Rate, lb/hr	0.000	0.000	0.000

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:		Depth	0		
Run Number:	EX-LT-IMP-02-021412			Area Used	0.349066
Test Date:	2/14/2012				
Run Time:	1105-1205				

md=	28.84
Ps=	29.59
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.1	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.66	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.203	<--CALCULATED
Actual Nozzle =	0.192	<--input
K Factor =	1.25	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.982	<--input

Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
0	1.2	581.045	1.50	52	64	92.5	3.460	3.411	61.2	1.095	1.25
5	1.2	584.505	1.50	70	65	97.8	3.601	3.543	62.2	1.095	1.28
10	1.2	588.106	1.54	74	65	98.0	3.595	3.538	62.5	1.095	1.27
15	1.2	591.701	1.53	79	67	95.8	3.509	3.440	62.8	1.095	1.27
20	1.2	595.21	1.52	79	68	95.2	3.496	3.420	62.8	1.095	1.27
25	1.2	598.706	1.52	82	69	98.1	3.600	3.516	62.9	1.095	1.26
30	1.2	602.306	1.52	82	69	106.4	3.902	3.810	62.9	1.095	1.26
35	1.2	606.208	1.52	88	69	93.0	3.393	3.313	63.3	1.095	1.25
40	1.2	609.601	1.50	86	71	98.0	3.594	3.496	63.2	1.095	1.26
45	1.2	613.195	1.51	89	73	100.9	3.707	3.593	63.3	1.095	1.26
50	1.2	616.902	1.51	91	75	100.5	3.699	3.572	63.5	1.095	1.26
55	1.2	620.601	1.51	91	75	92.5	3.402	3.285	63.5	1.095	1.26
60/off		624.003									
verages-->	1.20		1.51	80.25	69	97.40	3.580		62.83	1.10	

TOTAL VOLUME = 42.958

Blue = Input Items
Red = Calculated/Protected Items

md=	28.84
Ps=	29.68
Mfd=	0.980
Ms=	28.62

Operator's Initials:
Run Number: EX-LT-IMP-03-021512
Test Date: 2/15/2012
Run Time: 1110-1210

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.66	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.199 <--CALCULATED

Actual Nozzle = 0.192 <--input

K Factor = 1.26 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.982 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	624.175	1.51	88	63	128.5	4.628	4.585	63.2	1.095	1.26
2	5	1.2	628.803	1.51	91	63	97.6	3.504	3.471	63.4	1.095	1.23
3	10	1.2	632.307	1.47	91	64	100.0	3.600	3.559	63.4	1.095	1.23
4	15	1.2	635.907	1.48	93	66	94.3	3.402	3.351	63.5	1.095	1.23
5	20	1.2	639.309	1.48	93	67	99.5	3.594	3.533	63.5	1.095	1.23
6	25	1.2	642.903	1.48	103	68	97.5	3.499	3.433	64.0	1.095	1.21
7	30	1.2	646.402	1.46	107	68	98.1	3.507	3.441	64.3	1.095	1.20
8	35	1.2	649.909	1.45	110	68	98.1	3.498	3.432	64.4	1.095	1.20
9	40	1.2	653.407	1.44	111	72	97.2	3.488	3.396	64.5	1.095	1.21
10	45	1.2	656.895	1.45	113	73	94.9	3.406	3.310	64.6	1.095	1.20
11	50	1.2	660.301	1.44	111	74	91.8	3.308	3.209	64.5	1.095	1.21
12	55	1.2	663.609	1.45	111	75	94.0	3.392	3.285	64.5	1.095	1.21
Stop	60/off		667.001									
	Averages-->	1.20		1.47	101.83	68	99.30	3.569		63.97	1.10	

TOTAL VOLUME = 42.826

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-IMP-04-021612
Test Date: 2/16/2012
Run Time: 0940-1040

md=	28.84
Ps=	29.71
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.83	<--input
Delta H@	1.66	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.199 <--CALCULATED

Actual Nozzle = 0.192 <--input

K Factor = 1.26 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.982 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	667.118	1.38	71	64	99.3	3.485	3.448	59.5	1.049	1.26
2	5	1.1	670.603	1.38	74	63	99.7	3.482	3.452	59.7	1.049	1.27
3	10	1.1	674.085	1.39	79	65	98.1	3.422	3.380	60.0	1.049	1.26
4	15	1.1	677.507	1.39	82	65	97.7	3.400	3.358	60.1	1.049	1.25
5	20	1.1	680.907	1.38	82	67	100.1	3.497	3.441	60.1	1.049	1.26
6	25	1.1	684.404	1.38	85	69	94.4	3.302	3.236	60.3	1.049	1.26
7	30	1.1	687.706	1.38	85	70	99.8	3.495	3.419	60.3	1.049	1.26
8	35	1.1	691.201	1.38	85	71	94.2	3.307	3.229	60.3	1.049	1.26
9	40	1.1	694.508	1.39	87	72	96.8	3.396	3.310	60.4	1.049	1.26
10	45	1.1	697.904	1.38	88	73	96.9	3.403	3.310	60.5	1.049	1.26
11	50	1.1	701.307	1.38	84	73	93.6	3.299	3.209	60.2	1.049	1.27
12	55	1.1	704.606	1.39	93	74	98.8	3.461	3.361	60.7	1.049	1.25
Stop	60/off		708.067									
	Averages-->	1.10		1.39	82.92	69	97.44	3.412		60.18	1.05	

TOTAL VOLUME = 40.949

Distance from far wall to outside of port	36.25
Nipple length and/or wall thickness	10
Depth of stack or duct	26.25

% of depth	distance from inside wall	distance including nipple*
2.1	1.00	11.00
6.7	1.76	11.76
11.8	3.10	13.10
17.7	4.65	14.65
25	6.56	16.56
35.6	9.35	19.35
64.4	16.91	26.91
75	19.69	29.69
82.3	21.60	31.60
88.2	23.15	33.15
93.3	24.49	34.49
97.9	25.25	35.25

* mark these points on probe

EX-LT-M2-02.XLS

Burn Hut #1 Outlet Duct
VOLUMETRIC FLOW RATE TEST RESULTS

		PRE	POST	
	RUN NUMBER	EX-LT-M2-02-021412	EX-LT-M2-02-021412	
	RUN DATE	2/14/2012	2/14/2012	
	RUN TIME	1015	1245	
	MEASURED DATA			
(Pbar)	Barometric Pressure, inches Hg	29.71	29.71	
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	
(Ts)	Avg Stack Temp, deg F	81	81	
(%CO2)	Carbon Dioxide, %	0.0	0.0	
(%O2)	Oxygen, %	20.9	20.9	
(%N2)	Nitrogen, %	79.1	79.1	
(Cp)	Pitot Tube Coefficient	0.84	0.84	% difference
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.07	1.06	0.9
	CALCULATED DATA			
(Ps)	Stack Pressure, inches Hg	29.59	29.59	
(%H2O)	Moisture, % *	1.0	1.0	
(Mfd)	Dry Mole Fraction	0.990	0.990	
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	
(Ms)	Molecular Weight-wet, lb/lb-mole	28.73	28.73	
(Vs)	Velocity, ft/s	61.3	60.7	
(A)	Stack Area, ft²	0.35	0.35	AVERAGE
(Qa)	Volumetric flow, acfm	1,287	1,275	1,281
(Qs)	Volumetric flow, dscfm	1,230	1,218	1,224

* average of isokinetic runs conducted.

EX-LT-M2-03.XLS

Burn Hut #1 Outlet Duct
VOLUMETRIC FLOW RATE TEST RESULTS

		PRE	POST	
	RUN NUMBER	EX-LT-M2-03-021512	EX-LT-M2-03-021512	
	RUN DATE	2/15/2012	2/15/2012	
	RUN TIME	1100	1245	
	MEASURED DATA			
(Pbar)	Barometric Pressure, inches Hg	29.80	29.80	
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	
(Ts)	Avg Stack Temp, deg F	102	102	
(%CO2)	Carbon Dioxide, %	0.0	0.0	
(%O2)	Oxygen, %	20.9	20.9	
(%N2)	Nitrogen, %	79.1	79.1	
(Cp)	Pitot Tube Coefficient	0.84	0.84	% difference
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.07	1.07	0.0
	CALCULATED DATA			
(Ps)	Stack Pressure, inches Hg	29.68	29.68	
(%H2O)	Moisture, % *	1.0	1.0	
(Mfd)	Dry Mole Fraction	0.990	0.990	
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	
(Ms)	Molecular Weight-wet, lb/lb-mole	28.73	28.73	
(Vs)	Velocity, ft/s	62.4	62.4	
(A)	Stack Area, ft²	0.35	0.35	AVERAGE
(Qa)	Volumetric flow, acfm	1,310	1,310	1,310
(Qs)	Volumetric flow, dscfm	1,208	1,208	1,208

* average of isokinetic runs conducted.

Burn Hut #1 Outlet Duct
VOLUMETRIC FLOW RATE TEST RESULTS

		PRE	POST	
	RUN NUMBER	EX-LT-M2-04-021612	EX-LT-M2-04-021612	
	RUN DATE	2/16/2012	2/16/2012	
	RUN TIME	0915	1110	
	MEASURED DATA			
(Pbar)	Barometric Pressure, inches Hg	29.83	29.83	
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	
(Ts)	Avg Stack Temp, deg F	81	81	
(%CO2)	Carbon Dioxide, %	0.0	0.0	
(%O2)	Oxygen, %	20.9	20.9	
(%N2)	Nitrogen, %	79.1	79.1	
(Cp)	Pitot Tube Coefficient	0.84	0.84	% difference
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.04	1.04	0.0
	CALCULATED DATA			
(Ps)	Stack Pressure, inches Hg	29.71	29.71	
(%H2O)	Moisture, % *	1.0	1.0	
(Mfd)	Dry Mole Fraction	0.990	0.990	
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	
(Ms)	Molecular Weight-wet, lb/lb-mole	28.73	28.73	
(Vs)	Velocity, ft/s	59.5	59.5	
(A)	Stack Area, ft²	0.35	0.35	AVERAGE
(Qa)	Volumetric flow, acfm	1,249	1,249	1,249
(Qs)	Volumetric flow, dscfm	1,198	1,198	1,198

* average of isokinetic runs conducted.

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
MCE Filter Asbestos Test Results

	RUN NUMBER	EX-LT-MCE-01A-021312	EX-LT-MCE-01B-021312	EX-LT-MCE-01C-021312	EX-LT-MCE-01D-021312	EX-LT-MCE-01E-021312
	RUN DATE	2/13/2012	2/13/2012	2/13/2012	2/13/2012	2/13/2012
	RUN TIME	0	0	0	0	0
	MEASURED DATA					
(Y)	Meter Box Y	1.000	0.971	0.971	0.971	0.971
(DeltaH)	Avg Delta H, inches H2O	0.28	0.28	0.27	0.28	0.28
(Pbar)	Barometric Pressure, inches Hg	29.85	29.85	29.85	29.85	29.85
(Vm)	Meter Volume, ft^3	4.591	4.895	4.620	4.570	4.651
(Tm)	Avg Meter Temp, deg F	64	68	70	73	72
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	-1.60	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	54	72	85	81	57
(Vlc)	Water Collected, mL	0.00	0.00	0.00	0.00	0.00
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.049	1.049	1.049	1.049	1.049
(Theta)	Sample Time, min	15.0	15.0	15.0	15.0	15.0
(Dn)	Nozzle Diameter, inches	0.125	0.125	0.125	0.125	0.125
	CALCULATED DATA					
(An)	Nozzle Area, square feet	8.52212E-05	8.52212E-05	8.52212E-05	8.52212E-05	8.52212E-05
(Vmstd)	Standard Meter Volume, ft^3	4.614	4.743	4.457	4.387	4.473
(Ps)	Stack Pressure, inches Hg	29.73	29.73	29.73	29.73	29.73
(%H2O)	Moisture, %	0.0	0.0	0.0	0.0	0.0
(%H2Osat)	Moisture (at saturation), %	1.4	2.6	4.0	3.6	1.6
(Vwstd)	Standard Water Vapor Volume, ft^3	0.000	0.000	0.000	0.000	0.000
(Mfd)	Dry Mole Fraction	1.000	1.000	1.000	1.000	1.000
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.84	28.84	28.84	28.84	28.84
(Vs)	Velocity, ft/s	58.3	59.3	60.0	59.8	58.5
(A)	Stack Area, ft^2	0.35	0.35	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,221	1,242	1,257	1,253	1,225
(Qs)	Volumetric flow, dscfm	1,246	1,225	1,211	1,214	1,243
(I)	Isokinetic Rate, %	101.1	105.7	100.5	98.7	98.3

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-01B-021312
Test Date: 2/13/2012
Run Time:

md= 28.84
Ps= 29.73
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.85	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.120 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	409.688	0.27	59	68	98.9	1.520	1.473	58.8	1.049	0.25
2	5	1.1	411.208	0.27	75	67	118.8	1.795	1.743	59.7	1.049	0.26
3	10	1.1	413.003	0.28	81	69	104.8	1.580	1.528	60.1	1.049	0.25
Stop	15		414.583									
	Averages-->	1.10		0.28	71.67	68	107.51	1.632		59.53	1.05	

TOTAL VOLUME = 4.895

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-MCE-01C-021312
Test Date:	2/13/2012
Run Time:	

md=	28.84
Ps=	29.73
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.85	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.120 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	414.583	0.27	84	70	109.7	1.652	1.595	60.2	1.049	0.25
2	5	1.1	416.235	0.27	87	70	97.7	1.468	1.417	60.4	1.049	0.25
3	10	1.1	417.703	0.28	83	71	99.3	1.500	1.445	60.2	1.049	0.25
Stop	15		419.203									
	Averages-->	1.10		0.27	84.67	70	102.21	1.540		60.26	1.05	

TOTAL VOLUME = 4.62

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-MCE-01D-021312
Test Date:	2/13/2012
Run Time:	

md=	28.84
Ps=	29.73
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.85	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.120	<--CALCULATED
Actual Nozzle =	0.125	<--input
K Factor =	0.25	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.971	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	419.203	0.27	82	73	112.4	1.706	1.638	60.1	1.049	0.25
2	5	1.1	420.909	0.27	81	73	85.2	1.295	1.243	60.1	1.049	0.26
3	10	1.1	422.204	0.28	81	73	103.3	1.569	1.506	60.1	1.049	0.26
Stop	15		423.773									
	Averages-->	1.10		0.28	81.33	73	100.30	1.523		60.07	1.05	

TOTAL VOLUME = 4.57

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-01E-021312
Test Date: 2/13/2012
Run Time:

md=	28.84
Ps=	29.73
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.85	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.120 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	423.773	0.27	59	72	101.9	1.577	1.517	58.8	1.049	0.25
2	5	1.1	425.35	0.27	56	72	99.2	1.540	1.481	58.7	1.049	0.27
3	10	1.1	426.89	0.29	56	72	98.8	1.534	1.475	58.7	1.049	0.27
Stop	15		428.424									
	Averages-->	1.10		0.28	57.00	72	99.94	1.550		58.71	1.05	

TOTAL VOLUME = 4.651

Blue = Input Items
Red = Calculated/Protected Items

Facility Name: US EPA
Sampling Location: Burn Hut #1 Outlet Duct
City, State: RTP, NC
Operator's Initials: JTN
Run Number: EX-LT-MCE-01A-021312
Test Date: 2/13/2012
Run Time:

Stack Diameter (Rd): 8 Rd Area:=> 0.35
Stack Dimension (Rec): Rec Area:=> 0.00
Width 0
Depth 0
Area Used 0.349066

md= 28.84
Ps= 29.73
Mfd= 0.980
Ms= 28.62

K Factor Setup
Stack Temp. 80 <--input
Average Delta P 1.2 <--input
Meter Temp. 60 <--input
% Moisture 2 <--input
Sample Rate 0.27 <--input
Barometric Pres. 29.85 <--input
Delta H@ 1.85 <--input
Static Pressure -1.6 <--input
Pitot Coefficient 0.84 <--input
O2 % 20.9 <--input
CO2 % 0 <--input

Desired Nozzle = 0.120 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 1 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	405.097	0.27	53	64	101.0	1.505	1.513	58.5	1.049	0.25
2	5	1.1	406.602	0.27	53	64	101.0	1.505	1.513	58.5	1.049	0.26
3	10	1.1	408.107	0.29	56	65	106.3	1.581	1.587	58.7	1.049	0.26
Stop	15		409.688									
	Averages-->	1.10		0.28	54.00	64	102.79	1.530		58.54	1.05	

TOTAL VOLUME = 4.591

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
MCE Filter Asbestos Test Results

	RUN NUMBER	EX-LT-MCE-02A-021412	EX-LT-MCE-02B-021412	EX-LT-MCE-02C-021412	EX-LT-MCE-02D-021412	EX-LT-MCE-02E-021412
	RUN DATE	2/14/2012	2/14/2012	2/14/2012	2/14/2012	2/14/2012
	RUN TIME	1105-1120	1125-1136	1137-1152	1154-1209	1211-1226
	MEASURED DATA					
(Y)	Meter Box Y	1.000	0.971	0.971	0.971	0.971
(DeltaH)	Avg Delta H, inches H2O	0.30	0.30	0.30	0.30	0.30
(Pbar)	Barometric Pressure, inches Hg	29.71	29.71	29.71	29.71	29.71
(Vm)	Meter Volume, ft^3	4.927	4.666	4.666	4.650	4.673
(Tm)	Avg Meter Temp, deg F	64	66	68	72	71
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	-1.60	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	65	80	87	92	66
(Vlc)	Water Collected, mL	0.00	0.00	0.00	0.00	0.00
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.095	1.095	1.095	1.095	1.095
(Theta)	Sample Time, min	15.0	15.0	15.0	15.0	15.0
(Dn)	Nozzle Diameter, inches	0.125	0.125	0.125	0.125	0.125
	CALCULATED DATA					
(An)	Nozzle Area, square feet	8.52212E-05	8.52212E-05	8.52212E-05	8.52212E-05	8.52212E-05
(Vmstd)	Standard Meter Volume, ft^3	4.931	4.515	4.500	4.454	4.485
(Ps)	Stack Pressure, inches Hg	29.59	29.59	29.59	29.59	29.59
(%H2O)	Moisture, %	1.0	1.0	1.0	1.0	1.0
(%H2Osat)	Moisture (at saturation), %	2.1	3.5	4.4	5.1	2.2
(Vwstd)	Standard Water Vapor Volume, ft^3	0.000	0.000	0.000	0.000	0.000
(Mfd)	Dry Mole Fraction	0.990	0.990	0.990	0.990	0.990
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.73	28.73	28.73	28.73	28.73
(Vs)	Velocity, ft/s	61.8	62.7	63.1	63.4	61.9
(A)	Stack Area, ft^2	0.35	0.35	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,295	1,313	1,322	1,327	1,296
(Qs)	Volumetric flow, dscfm	1,274	1,257	1,249	1,243	1,273
(I)	Isokinetic Rate, %	105.7	98.1	98.4	97.8	96.2

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:	JTN	Depth	0		
Run Number:	EX-LT-MCE-02A-021412			Area Used	0.349066
Test Date:	2/14/2012				
Run Time:					

md= 28.84
Ps= 29.59
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.120 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 1 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	428.424	0.30	52	63	107.9	1.681	1.686	61.2	1.095	0.25
2	5	1.2	430.105	0.30	70	64	110.6	1.696	1.698	62.2	1.095	0.26
3	10	1.2	431.801	0.31	74	65	101.2	1.550	1.548	62.5	1.095	0.25
Stop	15		433.351									
	Averages-->	1.20		0.30	65.33	64	106.57	1.642		61.95	1.10	

TOTAL VOLUME = 4.927

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-02B-021412
Test Date: 2/14/2012
Run Time:

md=	28.84
Ps=	29.59
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.120	<--CALCULATED
Actual Nozzle =	0.125	<--input
K Factor =	0.25	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.971	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	433.351	0.30	79	66	92.5	1.454	1.408	62.8	1.095	0.25
2	5	1.2	434.805	0.30	79	66	101.6	1.598	1.547	62.8	1.095	0.25
3	10	1.2	436.403	0.30	82	67	102.7	1.614	1.560	62.9	1.095	0.25
Stop	15		438.017									
	Averages-->	1.20		0.30	80.00	66	98.94	1.555		62.81	1.10	

TOTAL VOLUME = 4.666

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-02C-021412
Test Date: 2/14/2012
Run Time:

md= 28.84
Ps= 29.59
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.120 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	438.017	0.30	86	68	101.0	1.584	1.528	63.2	1.095	0.25
2	5	1.2	439.601	0.30	88	68	96.7	1.514	1.460	63.3	1.095	0.25
3	10	1.2	441.115	0.30	87	68	100.1	1.568	1.512	63.2	1.095	0.25
Stop	15		442.683									
	Averages-->	1.20		0.30	87.00	68	99.26	1.555		63.22	1.10	

TOTAL VOLUME = 4.666

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-MCE-02D-021412
Test Date:	2/14/2012
Run Time:	

md=	28.84
Ps=	29.59
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.120	<--CALCULATED
Actual Nozzle =	0.125	<--input
K Factor =	0.25	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.971	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	442.683	0.30	90	70	96.8	1.518	1.459	63.4	1.095	0.25
2	5	1.2	444.201	0.30	91	75	95.2	1.506	1.434	63.5	1.095	0.25
3	10	1.2	445.707	0.30	94	70	104.0	1.626	1.562	63.6	1.095	0.25
Stop	15		447.333									
	Averages-->	1.20		0.30	91.67	72	98.67	1.550		63.49	1.10	

TOTAL VOLUME = 4.65

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-02E-021412
Test Date: 2/14/2012
Run Time:

md=	28.84
Ps=	29.59
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.120 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	447.333	0.30	69	70	98.5	1.576	1.514	62.2	1.095	0.25
2	5	1.2	448.909	0.30	65	71	99.2	1.595	1.530	61.9	1.095	0.26
3	10	1.2	450.504	0.31	64	71	93.3	1.502	1.441	61.9	1.095	0.26
Stop	15		452.006									
	Averages-->	1.20		0.30	66.00	71	97.00	1.558		62.00	1.10	

TOTAL VOLUME = 4.673

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
MCE Filter Asbestos Test Results

	RUN NUMBER	EX-LT-MCE-03A-021512	EX-LT-MCE-03B-021512	EX-LT-MCE-03C-021512	EX-LT-MCE-03D-021512	EX-LT-MCE-03E-021512
	RUN DATE	2/15/2012	2/15/2012	2/15/2012	2/15/2012	2/15/2012
	RUN TIME	1110-1125	1128-1143	1142-1157	1158-1213	1215-1230
	MEASURED DATA					
(Y)	Meter Box Y	0.971	0.971	0.971	0.971	0.971
(DeltaH)	Avg Delta H, inches H2O	0.30	0.30	0.30	0.30	0.30
(Pbar)	Barometric Pressure, inches Hg	29.80	29.80	29.80	29.80	29.80
(Vm)	Meter Volume, ft^3	3.813	4.788	4.663	4.677	4.814
(Tm)	Avg Meter Temp, deg F	63	65	68	70	71
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	-1.60	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	91	96	105	112	81
(Vlc)	Water Collected, mL	0.00	0.00	0.00	0.00	0.00
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.095	1.095	1.095	1.095	1.095
(Theta)	Sample Time, min	15.0	15.0	15.0	15.0	15.0
(Dn)	Nozzle Diameter, inches	0.125	0.125	0.125	0.125	0.125
	CALCULATED DATA					
(An)	Nozzle Area, square feet	8.52212E-05	8.52212E-05	8.52212E-05	8.52212E-05	8.52212E-05
(Vmstd)	Standard Meter Volume, ft^3	3.724	4.661	4.514	4.510	4.628
(Ps)	Stack Pressure, inches Hg	29.68	29.68	29.68	29.68	29.68
(%H2O)	Moisture, %	0.0	0.0	0.0	0.0	0.0
(%H2Osat)	Moisture (at saturation), %	4.9	5.8	7.6	9.3	3.6
(Vwstd)	Standard Water Vapor Volume, ft^3	0.000	0.000	0.000	0.000	0.000
(Mfd)	Dry Mole Fraction	1.000	1.000	1.000	1.000	1.000
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.84	28.84	28.84	28.84	28.84
(Vs)	Velocity, ft/s	63.1	63.4	63.9	64.3	62.5
(A)	Stack Area, ft^2	0.35	0.35	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,321	1,328	1,339	1,347	1,309
(Qs)	Volumetric flow, dscfm	1,257	1,250	1,240	1,233	1,268
(I)	Isokinetic Rate, %	80.9	101.8	99.4	99.9	99.7

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:	ST	Depth	0		
Run Number:	EX-LT-MCE-03A-021512			Area Used	0.349066
Test Date:	2/15/2012				
Run Time:					

md=	28.84
Ps=	29.68
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.119	<--CALCULATED
Actual Nozzle =	0.125	<--input
K Factor =	0.25	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.971	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	452.061	0.30	91	63	106.2	1.640	1.602	63.4	1.095	0.25
2	5	1.2	453.701	0.30	90	63	97.4	1.506	1.471	63.3	1.095	0.25
3	10	1.2	455.207	0.30			44.9	0.667	0.741	57.9	1.095	0.26
Stop	15		455.874									
	Averages-->	1.20		0.30	90.50	63	82.84	1.271		61.51	1.10	

TOTAL VOLUME = 3.813

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-03B-021512
Test Date: 2/15/2012
Run Time:

md= 28.84
Ps= 29.68
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.119 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	455.874	0.30	93	66	98.8	1.532	1.488	63.5	1.095	0.25
2	5	1.2	457.406	0.30	93	64	103.3	1.595	1.555	63.5	1.095	0.25
3	10	1.2	459.001	0.29	103	64	108.5	1.661	1.619	64.0	1.095	0.24
Stop	15		460.662									
	Averages-->	1.20		0.30	96.33	65	103.55	1.596		63.66	1.10	

TOTAL VOLUME = 4.788

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-MCE-03C-021512
Test Date:	2/15/2012
Run Time:	

md=	28.84
Ps=	29.68
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.119	<--CALCULATED
Actual Nozzle =	0.125	<--input
K Factor =	0.25	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.971	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	460.662	0.30	103	65	100.4	1.540	1.498	64.0	1.095	0.25
2	5	1.2	462.202	0.30	103	66	97.8	1.503	1.460	64.0	1.095	0.24
3	10	1.2	463.705	0.29	110	72	104.9	1.620	1.555	64.4	1.095	0.24
Stop	15		465.325									
	Averages-->	1.20		0.30	105.33	68	101.05	1.554		64.17	1.10	

TOTAL VOLUME = 4.663

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-03D-021512
Test Date: 2/15/2012
Run Time:

md=	28.84
Ps=	29.68
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.119 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	465.325	0.30	111	69	102.8	1.577	1.523	64.5	1.095	0.25
2	5	1.2	466.902	0.30	111	70	97.9	1.505	1.451	64.5	1.095	0.24
3	10	1.2	468.407	0.29	115	70	104.1	1.595	1.537	64.7	1.095	0.24
Stop	15		470.002									
	Averages-->	1.20		0.30	112.33	70	101.61	1.559		64.57	1.10	

TOTAL VOLUME = 4.677

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-MCE-03E-021512
Test Date:	2/15/2012
Run Time:	

md=	28.84
Ps=	29.68
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.119 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	470.002	0.30	88	71	103.2	1.623	1.561	63.2	1.095	0.25
2	5	1.2	471.625	0.30	79	71	100.9	1.600	1.539	62.7	1.095	0.26
3	10	1.2	473.225	0.31	75	72	99.8	1.591	1.528	62.4	1.095	0.26
Stop	15		474.816									
	Averages-->	1.20		0.30	80.67	71	101.33	1.605		62.76	1.10	

TOTAL VOLUME = 4.814

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
MCE Filter Asbestos Test Results

	RUN NUMBER	EX-LT-MCE-04A-021612	EX-LT-MCE-04B-021612	EX-LT-MCE-04C-021612	EX-LT-MCE-03D-021512	EX-LT-MCE-04E-021612
	RUN DATE	2/16/2012	2/16/2012	2/16/2012	2/15/2012	2/16/2012
	RUN TIME	0940-0955	0956-1011	1013-1028	1029-1044	1046-1101
	MEASURED DATA					
(Y)	Meter Box Y	0.971	0.971	0.971	0.971	0.971
(DeltaH)	Avg Delta H, inches H2O	0.28	0.28	0.28	0.28	0.28
(Pbar)	Barometric Pressure, inches Hg	29.83	29.83	29.83	29.80	29.83
(Vm)	Meter Volume, ft^3	4.603	4.879	4.520	4.840	4.790
(Tm)	Avg Meter Temp, deg F	65	66	67	68	69
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	-1.60	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	75	82	86	85	64
(Vlc)	Water Collected, mL	0.00	0.00	0.00	0.00	0.00
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.049	1.049	1.049	1.049	1.049
(Theta)	Sample Time, min	15.0	15.0	15.0	15.0	15.0
(Dn)	Nozzle Diameter, inches	0.125	0.125	0.125	0.125	0.125
	CALCULATED DATA					
(An)	Nozzle Area, square feet	8.52212E-05	8.52212E-05	8.52212E-05	8.52212E-05	8.52212E-05
(Vmstd)	Standard Meter Volume, ft^3	4.486	4.746	4.388	4.682	4.630
(Ps)	Stack Pressure, inches Hg	29.71	29.71	29.71	29.68	29.71
(%H2O)	Moisture, %	0.0	0.0	0.0	0.0	0.0
(%H2Osat)	Moisture (at saturation), %	2.9	3.7	4.2	4.1	2.0
(Vwstd)	Standard Water Vapor Volume, ft^3	0.000	0.000	0.000	0.000	0.000
(Mfd)	Dry Mole Fraction	1.000	1.000	1.000	1.000	1.000
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.84	28.84	28.84	28.84	28.84
(Vs)	Velocity, ft/s	59.5	59.9	60.1	60.1	58.9
(A)	Stack Area, ft^2	0.35	0.35	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,246	1,255	1,259	1,259	1,234
(Qs)	Volumetric flow, dscfm	1,222	1,213	1,209	1,209	1,234
(I)	Isokinetic Rate, %	100.3	106.9	99.1	105.7	102.5

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:	ST	Depth	0		
Run Number:	EX-LT-MCE-04A-021612			Area Used	0.349066
Test Date:	2/16/2012				
Run Time:					

md= 28.84
Ps= 29.71
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.83	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.119 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	474.806	0.28	71	64	105.8	1.595	1.556	59.5	1.049	0.25
2	5	1.1	476.401	0.28	74	65	99.8	1.504	1.465	59.7	1.049	0.25
3	10	1.1	477.905	0.28	79	65	100.3	1.504	1.465	60.0	1.049	0.25
Stop	15		479.409									
	Averages-->	1.10		0.28	74.67	65	101.95	1.534		59.72	1.05	

TOTAL VOLUME = 4.603

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-04B-021612
Test Date: 2/16/2012
Run Time:

md= 28.84
Ps= 29.71
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.83	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.119 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	479.409	0.28	80	65	113.0	1.693	1.649	60.0	1.049	0.25
2	5	1.1	481.102	0.28	82	66	106.7	1.599	1.554	60.1	1.049	0.25
3	10	1.1	482.701	0.28	85	66	106.2	1.587	1.543	60.3	1.049	0.25
Stop	15		484.288									
	Averages-->	1.10		0.28	82.33	66	108.63	1.626		60.15	1.05	

TOTAL VOLUME = 4.879

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-04C-021612
Test Date: 2/16/2012
Run Time:

md= 28.84
Ps= 29.71
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.83	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.119 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	484.288	0.28	85	66	101.3	1.514	1.472	60.3	1.049	0.25
2	5	1.1	485.802	0.28	86	67	100.5	1.504	1.459	60.4	1.049	0.25
3	10	1.1	487.306	0.27	86	67	100.4	1.502	1.457	60.4	1.049	0.25
Stop	15		488.808									
	Averages-->	1.10		0.28	85.67	67	100.76	1.507		60.33	1.05	

TOTAL VOLUME = 4.52

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-MCE-03D-021512
Test Date: 2/15/2012
Run Time:

md= 28.84
Ps= 29.68
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.119 <--CALCULATED

Actual Nozzle = 0.125 <--input

K Factor = 0.25 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.971 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	488.808	0.28	85	68	112.7	1.692	1.637	60.3	1.049	0.25
2	5	1.1	490.5	0.28	85	68	100.5	1.508	1.459	60.3	1.049	0.25
3	10	1.1	492.008	0.28	85	68	109.3	1.640	1.586	60.3	1.049	0.25
Stop	15		493.648									
	Averages-->	1.10		0.28	85.00	68	107.50	1.613		60.33	1.05	

TOTAL VOLUME = 4.84

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:		
Run Number:	EX-LT-MCE-04E-021612	
Test Date:	2/16/2012	
Run Time:		

md=	28.84
Ps=	29.71
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.27	<--input
Barometric Pres.	29.83	<--input
Delta H@	1.85	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.119	<--CALCULATED
Actual Nozzle =	0.125	<--input
K Factor =	0.25	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.971	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	493.648	0.28	69	69	102.0	1.556	1.504	59.4	1.049	0.25
2	5	1.1	495.204	0.28	64	69	107.1	1.641	1.586	59.1	1.049	0.26
3	10	1.1	496.845	0.29	60	69	103.5	1.593	1.540	58.9	1.049	0.26
Stop	15		498.438									
	Averages-->	1.10		0.28	64.33	69	104.20	1.597		59.14	1.05	

TOTAL VOLUME = 4.79

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
Particulate Test Results

	RUN NUMBER	EX-LT-PM-01-021312
	RUN DATE	2/13/2012
	RUN TIME	1231-1331
	MEASURED DATA	
(Y)	Meter Box Y	0.986
(DeltaH)	Avg Delta H, inches H2O	1.38
(Pbar)	Barometric Pressure, inches Hg	29.85
(Vm)	Meter Volume, ft³	41.226
(Tm)	Avg Meter Temp, deg F	71
(Pg)	Static Pressure, inches H2O	-1.60
(Ts)	Avg Stack Temp, deg F	74
(Vlc)	Water Collected, mL	5.56
(%CO2)	Carbon Dioxide, %	0.0
(%O2)	Oxygen, %	20.9
(%N2)	Nitrogen, %	79.1
(Cp)	Pitot Tube Coefficient	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.049
(Theta)	Sample Time, min	60.0
(Dn)	Nozzle Diameter, inches	0.190
	CALCULATED DATA	
(An)	Nozzle Area, square feet	0.000196895
(Vmstd)	Standard Meter Volume, ft³	40.452
(Ps)	Stack Pressure, inches Hg	29.73
(%H2O)	Moisture, %	0.6
(%H2Osat)	Moisture (at saturation), %	2.8
(Vwstd)	Standard Water Vapor Volume, ft³	0.262
(Mfd)	Dry Mole Fraction	0.994
(Md)	Molecular Weight-dry, lb/lb-mole	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.77
(Vs)	Velocity, ft/s	59.5
(A)	Stack Area, ft²	0.35
(Qa)	Volumetric flow, acfm	1,246
(Qs)	Volumetric flow, dscfm	1,216
(I)	Isokinetic Rate, %	98.3
	EMISSIONS DATA	
	Particulate	
(mg)	Catch, milligrams	4.10
(gr/DSCF)	Concentration, gr/DSCF	0.00156
(mg/DSCM)	Concentration, mg/DSCM	3.58
(lb/hr)	Emission Rate, lb/hr	0.016

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:		Depth	0		
Run Number:	EX-LT-PM-01-021312			Area Used	0.349066
Test Date:	2/13/2012				
Run Time:	1231-1331				

md=	28.84
Ps=	29.73
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.85	<--input
Delta H@	1.7	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.200	<--CALCULATED
Actual Nozzle =	0.190	<--input
K Factor =	1.22	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.986	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	713.989	1.35	53	66	97.6	3.411	3.378	58.5	1.049	1.22
2	5	1.1	717.4	1.35	53	66	97.3	3.400	3.367	58.5	1.049	1.30
3	10	1.1	720.8	1.43	58	67	95.9	3.340	3.302	58.8	1.049	1.29
4	15	1.1	724.14	1.42	60	68	100.8	3.510	3.463	58.9	1.049	1.29
5	20	1.1	727.65	1.42	74	70	101.4	3.500	3.441	59.7	1.049	1.26
6	25	1.1	731.15	1.39	81	70	98.9	3.390	3.332	60.1	1.049	1.24
7	30	1.1	734.54	1.37	83	70	101.4	3.470	3.411	60.2	1.049	1.24
8	35	1.1	738.01	1.36	83	73	102.9	3.540	3.460	60.2	1.049	1.25
9	40	1.1	741.55	1.37	87	73	100.9	3.460	3.382	60.4	1.049	1.24
10	45	1.1	745.01	1.36	87	75	97.1	3.340	3.252	60.4	1.049	1.24
11	50	1.1	748.35	1.37	84	76	101.2	3.500	3.402	60.2	1.049	1.25
12	55	1.1	751.85	1.38	84	77	97.1	3.365	3.264	60.2	1.049	1.25
Stop	60/off		755.215									
	Averages-->	1.10		1.38	73.92	71	99.38	3.436		59.66	1.05	

TOTAL VOLUME = 41.226

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-PM-02-021412
Test Date:	2/14/2012
Run Time:	1105-1205

md= 28.84
Ps= 29.59
Mfd= 0.980
Ms= 28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.7	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.199 <--CALCULATED

Actual Nozzle = 0.190 <--input

K Factor = 1.22 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.986 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.22
2	5			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
3	10			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
4	15			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
5	20			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
6	25			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
7	30			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
8	35			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
9	40			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
10	45			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
11	50			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
12	55			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
Stop	60/off											
	Averages-->	#DIV/0!		0.00	#DIV/0!	#DIV/0!	#DIV/0!	0.000		0.00	0.00	

TOTAL VOLUME = 0

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-PM-03-021512
Test Date:	2/15/2012
Run Time:	1110-1210

md=	28.84
Ps=	29.68
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.7	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.199 <--CALCULATED

Actual Nozzle = 0.190 <--input

K Factor = 1.24 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.986 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.24
2	5			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
3	10			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
4	15			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
5	20			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
6	25			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
7	30			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
8	35			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
9	40			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
10	45			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
11	50			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
12	55			0.00			#DIV/0!	0.000	0.000	0.0	0.000	1.27
Stop	60/off											
	Averages-->	#DIV/0!		0.00	#DIV/0!	#DIV/0!	#DIV/0!	0.000		0.00	0.00	

TOTAL VOLUME = 0

Distance from far wall to outside of port	36.25
Nipple length and/or wall thickness	10
Depth of stack or duct	26.25

% of depth	distance from inside wall	distance including nipple*
2.1	1.00	11.00
6.7	1.76	11.76
11.8	3.10	13.10
17.7	4.65	14.65
25	6.56	16.56
35.6	9.35	19.35
64.4	16.91	26.91
75	19.69	29.69
82.3	21.60	31.60
88.2	23.15	33.15
93.3	24.49	34.49
97.9	25.25	35.25

* mark these points on probe

US EPA
Burn Hut #1 Outlet Duct
RTP, NC
Particulate Test Results

	RUN NUMBER	EX-LT-PM-02-021412	EX-LT-PM-03-021512	EX-LT-PM-04-021612
	RUN DATE	2/14/2012	2/15/2012	2/16/2012
	RUN TIME	1105-1205	1110-1210	0940-1040
	MEASURED DATA			
(Y)	Meter Box Y	0.986	0.986	0.986
(DeltaH)	Avg Delta H, inches H2O	1.49	1.44	1.37
(Pbar)	Barometric Pressure, inches Hg	29.71	29.80	29.83
(Vm)	Meter Volume, ft^3	42.905	41.936	41.095
(Tm)	Avg Meter Temp, deg F	71	69	70
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	81	102	81
(Vlc)	Water Collected, mL	7.33	7.00	7.55
(%CO2)	Carbon Dioxide, %	0.0	0.0	0.0
(%O2)	Oxygen, %	20.9	20.9	20.9
(%N2)	Nitrogen, %	79.1	79.1	79.1
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.095	1.095	1.049
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.190	0.190	0.190
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.000196895	0.000196895	0.000196895
(Vmstd)	Standard Meter Volume, ft^3	41.934	41.222	40.358
(Ps)	Stack Pressure, inches Hg	29.59	29.68	29.71
(%H2O)	Moisture, %	0.8	0.8	0.9
(%H2Osat)	Moisture (at saturation), %	3.6	6.8	3.6
(Vwstd)	Standard Water Vapor Volume, ft^3	0.346	0.330	0.356
(Mfd)	Dry Mole Fraction	0.992	0.992	0.991
(Md)	Molecular Weight-dry, lb/lb-mole	28.84	28.84	28.84
(Ms)	Molecular Weight-wet, lb/lb-mole	28.75	28.75	28.74
(Vs)	Velocity, ft/s	62.7	63.8	60.0
(A)	Stack Area, ft^2	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,314	1,336	1,256
(Qs)	Volumetric flow, dscfm	1,257	1,236	1,205
(I)	Isokinetic Rate, %	98.6	98.5	99.0
	EMISSIONS DATA			
	Particulate			
(mg)	Catch, milligrams	6.90	11.00	11.700
(gr/DSCF)	Concentration, gr/DSCF	0.00254	0.00412	0.00447
(mg/DSCM)	Concentration, mg/DSCM	5.81	9.42	10.2
(lb/hr)	Emission Rate, lb/hr	0.0274	0.0436	0.0462

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:	US EPA	Stack Diameter (Rd):	8	Rd Area:=>	0.35
Sampling Location:	Burn Hut #1 Outlet Duct	Stack Dimension (Rec):		Rec Area:=>	0.00
City, State:	RTP, NC	Width	0		
Operator's Initials:		Depth	0		
Run Number:	EX-LT-PM-02-021412			Area Used	0.349066
Test Date:	2/14/2012				
Run Time:	1105-1205				

md=	28.84
Ps=	29.59
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	60	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.71	<--input
Delta H@	1.7	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle = 0.199 <--CALCULATED

Actual Nozzle = 0.190 <--input

K Factor = 1.22 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.986 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	755.445	1.47	60	66	97.6	3.545	3.495	61.6	1.095	1.22
2	5	1.2	758.99	1.47	71	66	101.5	3.650	3.599	62.3	1.095	1.26
3	10	1.2	762.64	1.51	74	68	96.2	3.460	3.399	62.5	1.095	1.26
4	15	1.2	766.1	1.51	79	69	102.9	3.690	3.618	62.8	1.095	1.25
5	20	1.2	769.79	1.50	79	69	99.5	3.570	3.500	62.8	1.095	1.25
6	25	1.2	773.36	1.50	82	69	99.5	3.560	3.490	62.9	1.095	1.24
7	30	1.2	776.92	1.49	82	72	98.9	3.560	3.471	62.9	1.095	1.25
8	35	1.2	780.48	1.50	88	73	97.9	3.510	3.416	63.3	1.095	1.24
9	40	1.2	783.99	1.48	87	73	102.6	3.680	3.581	63.2	1.095	1.24
10	45	1.2	787.67	1.49	87	74	99.6	3.580	3.477	63.2	1.095	1.24
11	50	1.2	791.25	1.49	89	74	96.1	3.450	3.351	63.3	1.095	1.24
12	55	1.2	794.7	1.48	93	75	101.9	3.650	3.538	63.6	1.095	1.23
Stop	60/off		798.35									
	Averages-->	1.20		1.49	80.92	71	99.52	3.575		62.87	1.10	

TOTAL VOLUME = 42.905

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:	
Run Number:	EX-LT-PM-03-021512
Test Date:	2/15/2012
Run Time:	1110-1210

md=	28.84
Ps=	29.68
Mfd=	0.980
Ms=	28.62

K Factor Setup

Stack Temp.	80	<--input
Average Delta P	1.2	<--input
Meter Temp.	65	<--input
% Moisture	2	<--input
Sample Rate	0.75	<--input
Barometric Pres.	29.8	<--input
Delta H@	1.7	<--input
Static Pressure	-1.6	<--input
Pitot Coefficient	0.84	<--input
O2 %	20.9	<--input
CO2 %	0	<--input

Desired Nozzle =	0.199	<--CALCULATED
Actual Nozzle =	0.190	<--input
K Factor =	1.24	<--CALCULATED
Minutes/Point =	5	<--input
Meter Box Gamma =	0.986	<--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.2	798.493	1.48	91	64	103.3	3.627	3.601	63.4	1.095	1.24
2	5	1.2	802.12	1.48	91	65	97.8	3.440	3.409	63.4	1.095	1.21
3	10	1.2	805.56	1.45	90	65	101.1	3.560	3.527	63.3	1.095	1.21
4	15	1.2	809.12	1.46	92	67	99.8	3.520	3.474	63.4	1.095	1.21
5	20	1.2	812.64	1.46	91	68	95.3	3.370	3.320	63.4	1.095	1.22
6	25	1.2	816.01	1.46	103	68	102.0	3.570	3.517	64.0	1.095	1.19
7	30	1.2	819.58	1.43	106	70	99.1	3.470	3.405	64.2	1.095	1.19
8	35	1.2	823.05	1.43	106	70	98.2	3.440	3.376	64.2	1.095	1.19
9	40	1.2	826.49	1.43	111	71	99.9	3.490	3.419	64.5	1.095	1.18
10	45	1.2	829.98	1.42	116	73	102.2	3.570	3.484	64.8	1.095	1.18
11	50	1.2	833.55	1.41	110	74	97.8	3.440	3.351	64.4	1.095	1.19
12	55	1.2	836.99	1.43	111	75	97.7	3.439	3.343	64.5	1.095	1.19
Stop	60/off		840.429									
	Averages-->	1.20		1.44	101.50	69	99.52	3.495		63.95	1.10	

TOTAL VOLUME = 41.936

Blue = Input Items
Red = Calculated/Protected Items

Operator's Initials:
Run Number: EX-LT-PM-04-021612
Test Date: 2/16/2012
Run Time: 0940-1040

md= 28.84
Ps= 29.71
Mfd= 0.980
Ms= 28.62

K Factor Setup
- Stack Temp. 80 <--input
- Average Delta P 1.2 <--input
- Meter Temp. 65 <--input
- % Moisture 2 <--input
- Sample Rate 0.75 <--input
- Barometric Pres. 29.83 <--input
- Delta H@ 1.7 <--input
- Static Pressure -1.6 <--input
- Pitot Coefficient 0.84 <--input
- O2 % 20.9 <--input
- CO2 % 0 <--input

Desired Nozzle = 0.199 <--CALCULATED

Actual Nozzle = 0.190 <--input

K Factor = 1.24 <--CALCULATED

Minutes/Point = 5 <--input

Meter Box Gamma = 0.986 <--input

Sample Point	Elapsed Time	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P	K-factor
1	0	1.1	840.654	1.36	64	66	101.1	3.496	3.460	59.1	1.049	1.24
2	5	1.1	844.15	1.36	65	67	99.1	3.430	3.388	59.2	1.049	1.28
3	10	1.1	847.58	1.40	80	67	101.7	3.470	3.428	60.0	1.049	1.24
4	15	1.1	851.05	1.36	79	68	99.6	3.410	3.362	60.0	1.049	1.24
5	20	1.1	854.46	1.37	82	69	99.4	3.400	3.346	60.1	1.049	1.24
6	25	1.1	857.86	1.36	83	70	100.8	3.450	3.389	60.2	1.049	1.24
7	30	1.1	861.31	1.36	84	71	100.7	3.450	3.382	60.2	1.049	1.24
8	35	1.1	864.76	1.36	85	71	100.8	3.450	3.382	60.3	1.049	1.24
9	40	1.1	868.21	1.36	87	72	96.4	3.300	3.229	60.4	1.049	1.24
10	45	1.1	871.51	1.36	88	73	101.8	3.490	3.409	60.5	1.049	1.24
11	50	1.1	875	1.36	86	73	98.5	3.380	3.301	60.4	1.049	1.24
12	55	1.1	878.38	1.36	93	74	98.6	3.369	3.284	60.7	1.049	1.23
Stop	60/off		881.749									
	Averages-->	1.10		1.37	81.33	70	99.87	3.425		60.09	1.05	

TOTAL VOLUME = 41.095

Distance from far wall to outside of port	36.25
Nipple length and/or wall thickness	10
Depth of stack or duct	26.25

% of depth	distance from inside wall	distance including nipple*
2.1	1.00	11.00
6.7	1.76	11.76
11.8	3.10	13.10
17.7	4.65	14.65
25	6.56	16.56
35.6	9.35	19.35
64.4	16.91	26.91
75	19.69	29.69
82.3	21.60	31.60
88.2	23.15	33.15
93.3	24.49	34.49
97.9	25.25	35.25

* mark these points on probe

USEPA

Burn Hut #1 Exhaust Duct

RTP, NC

$PM_{2.5}$ Test Results

RUN NUMBER	EX-LT-PM2.5-01-021312
RUN DATE	2/13/2012
RUN TIME	1231-1331

MEASURED DATA

(Y)	Meter Box Y	0.886
(DeltaH)	Avg Delta H, inches H2O	0.58
(Pbar)	Barometric Pressure, inches Hg	29.85
(Vm)	Meter Volume, ft³	30.512
(Tm)	Avg Meter Temp, deg F	71
(Pg)	Static Pressure, inches H2O	-1.60
(Ts)	Avg Stack Temp, deg F	74
(Vlc)	Water Collected, mL	0.0
(%CO2)	Carbon Dioxide, %	2.0
(%O2)	Oxygen, %	17.0
(%N2)	Nitrogen, %	81.0
(Cp)	Pitot Tube Coefficient	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.049
(Theta)	Sample Time, min	60.0
(Dn)	Nozzle Diameter, inches	0.156

CALCULATED DATA

(An)	Nozzle Area, square feet	0.00013273
(Vmstd)	Standard Meter Volume, ft³	26.867
(Ps)	Stack Pressure, inches Hg	29.73
(%H2O)	Moisture, %	0.0
(%H2Osat)	Moisture (at saturation), %	2.8
(Vwstd)	Standard Water Vapor Volume, ft³	0.000
(Mfd)	Dry Mole Fraction	1.000
(Md)	Molecular Weight-dry, lb/lb-mole	29.00
(Ms)	Molecular Weight-wet, lb/lb-mole	29.00
(Vs)	Velocity, ft/s	59.3
(A)	Stack Area, ft²	0.35
(Qa)	Volumetric flow, acfm	1,241
(Qs)	Volumetric flow, dscfm	1,219
(I)	Isokinetic Rate, %	96.6
(vis)	Stack Gas Viscocity	179.8
(sf)	Sample Flow, acfm	0.46
(cpm10)	PM10 Cut Point, microns	9.80
(cpm2.5)	PM2.5 Cut Point, microns	2.43

(continued next page)

Burn Hut #1 Exhaust Duct

$PM_{2.5}$ Test Results

(continued)

RUN NUMBER EX-LT-PM2.5-01-021312
RUN DATE 2/13/2012
RUN TIME 1231-1331

EMISSIONS DATA

	FILTERABLE PARTICULATE $\leq$ 2.5um	
(mg)	Catch, milligrams	0.0
(gr/DSCF)	Concentration, gr/DSCF	0.000000
(mg/DSCM)	Concentration, mg/DSCM	0.00
(lb/hr)	Emission Rate, lb/hr	0.0000
	FILTERABLE PARTICULATE > 2.5um	
(mg)	Catch, milligrams	0.0
(gr/DSCF)	Concentration, gr/DSCF	0.00000
(mg/DSCM)	Concentration, mg/DSCM	0.00
(lb/hr)	Emission Rate, lb/hr	0.0000
	TOTAL FILTERABLE PARTICULATE	
(mg)	Catch, milligrams	0.0
(gr/DSCF)	Concentration, gr/DSCF	0.00000
(mg/DSCM)	Concentration, mg/DSCM	0.00
(lb/hr)	Emission Rate, lb/hr	0.000

BAROMETRIC PRESSURE, in. Hg = 29.85
STACK STATIC PRESSURE, in. H2O = -1.7
AVG. STACK TEMPERATURE, deg. F = 80
METER TEMPERATURE, deg. F 60
ORIFICE DELTA H@, in H20 = 1.77

%CO2 = 2
%O2 = 17
%N2+%CC 81
MOISTURE FRACTIC 0.01 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	80	130	30
DELTA H, IN H2O	0.578942	0.58747	0.572595

MW (DRY)	29.00		
MW (WET)	28.89		
PS=	29.725		
VIS=	181.33	194.43	168.40
CYC FLOV	0.4487	0.4938	0.4049

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	56.34159	46.89063	40.0622	34.62359	31.09136	28.32911
MIN VEL ft/sec	41.00651	32.94412	26.95855	22.00629	18.62404	15.80689
MAX VEL ft/sec	70.31695	59.20815	51.22264	44.89615	40.80794	37.62478
DEL. P MIN in. H2O	0.51868	0.334772	0.224175	0.149378	0.10699	0.07707
DEL. P MAX in. H2O	1.525154	1.081326	0.809315	0.621744	0.513668	0.436658

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.10	60.0	60.0	80
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	1.100	60.0		80

BAROMETRIC PRESSURE, in. Hg = 29.71
STACK STATIC PRESSURE, in. H2O = -1.6
AVG. STACK TEMPERATURE, deg. F = 80
METER TEMPERATURE, deg. F 60
ORIFICE DELTA H@, in H20 = 1.77
%CO2 = 2
%O2 = 17
%N2+%CC 81
MOISTURE FRACTIC 0.02 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	80	130	30
DELTA H, IN H2O	0.563038	0.571648	0.556515

MW (DRY)	29.00		
MW (WET)	28.78		
PS=	29.59235		
VIS=	180.59	193.69	167.66
CYC FLOW	0.4479	0.4931	0.4041

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	56.24852	46.81317	39.99603	34.5664	31.04	28.28231
MIN VEL ft/sec	40.94941	32.90201	26.92826	21.98672	18.61281	15.80393
MAX VEL ft/sec	70.1944	59.10346	51.13072	44.8143	40.73256	37.55443
DEL. P MIN in. H2O	0.512968	0.331161	0.221825	0.147882	0.105979	0.076405
DEL. P MAX in. H2O	1.507299	1.068613	0.799757	0.614367	0.507549	0.431436

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.20	60.0	60.0	80
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	1.200	60.0		80

BAROMETRIC PRESSURE, in. Hg = 29.8
STACK STATIC PRESSURE, in. H2O = -1.6
AVG. STACK TEMPERATURE, deg. F = 80
METER TEMPERATURE, deg. F 65
ORIFICE DELTA H@, in H20 = 1.77
%CO2 = 2
%O2 = 17
%N2+%C 81
MOISTURE FRACTI 0.02 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	80	130	30
DELTA H, IN H2O	0.569167	0.577871	0.562573

MW (DRY)	29.00		
MW (WET	28.78		
PS=	29.68235		
VIS=	180.59	193.69	167.66
CYC FLO	0.4475	0.4927	0.4037

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	56.19817	46.77127	39.96022	34.53546	31.01221	28.257
MIN VEL ft/sec	40.90887	32.86806	26.89895	21.96091	18.58901	15.78132
MAX VEL ft/sec	70.13391	59.05307	51.08762	44.777	40.69901	37.52381
DEL. P MIN in. H2O	0.513509	0.331483	0.222016	0.147984	0.106029	0.076419
DEL. P MAX in. H2O	1.509279	1.070036	0.800838	0.61521	0.508254	0.432043

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.20	60.0	60.0	80
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL	1.200	60.0		80

Blue = Input Items
Red = Calculated/Protected Items

Facility Name: USEPA
Sampling Location: Burn Hut #1 Exhaust Duc
City, State: RTP, NC
Operator's Initials:
Run Number: EX-LT-PM2.5-01-021312
Test Date: 2/13/2012
Run Time: 1231-1331

Stack Diameter (Rd): 8 Rd Area:=> 0.35
Stack Dimension (Rec): Rec Area:=> 0.00
Width 0
Depth 0
Area Used 0.349066

md= 29.00
Ps= 29.73

Mfd= 0.990
Ms= 28.89

Static Pressure = -1.6
Stack Temp = 80
Meter Temp = 60
CO2 = 2
O2 = 17
Barometric Pres. = 29.85
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 1 ex: 1% = 1%

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1.1	538.062	0.58	53	67	97.1	2.568	2.277	58.2	1.049
2	5.0	1.1	540.63	0.58	53	67	96.0	2.540	2.252	58.2	1.049
3	5.0	1.1	543.17	0.58	58	67	93.8	2.470	2.190	58.5	1.049
4	5.0	1.1	545.64	0.58	60	68	97.2	2.560	2.265	58.6	1.049
5	5.0	1.1	548.2	0.58	74	69	98.7	2.570	2.270	59.4	1.049
6	5.0	1.1	550.77	0.58	81	70	97.6	2.530	2.230	59.8	1.049
7	5.0	1.1	553.3	0.58	83	70	97.8	2.530	2.230	59.9	1.049
8	5.0	1.1	555.83	0.58	83	72	98.6	2.560	2.248	59.9	1.049
9	5.0	1.1	558.39	0.58	87	73	98.4	2.550	2.235	60.1	1.049
10	5.0	1.1	560.94	0.58	87	74	97.8	2.540	2.222	60.1	1.049
11	5.0	1.1	563.48	0.58	84	74	98.3	2.560	2.240	59.9	1.049
12	5.0	1.1	566.04	0.58	84	76	97.0	2.534	2.209	59.9	1.049
	60.0		568.574								
	Averages-->	1.10		0.58	73.92	70.58	97.38			59.38	1.05

TOTAL VOLUME = 30.512

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:
Sampling Location:
City, State:
Operator's Initials:
Run Number: EX-LT-PM2.5-02-021412
Test Date: 2/14/2012
Run Time: 1105-1205

Stack Diameter (Rd): input
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> #VALUE!
Rec Area:=> 0.00
Area Used #VALUE!

Static Pressure = -1.6
Stack Temp = 80
Meter Temp = 60
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.71
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 2 ex: 1% = 1%

md= 28.84
Ps= 29.59

Mfd= 0.980
Ms= 28.62

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Average Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
2	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
3	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
4	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
5	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
6	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
7	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
8	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
9	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
10	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
11	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
12	5.0	1.2		0.56			0.0	0.000	0.000	58.0	1.095
Stop	60.0										
	Averages-->	1.20		0.56	#DIV/0!	#DIV/0!	0.00			57.98	1.10

TOTAL VOLUME = 0

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:
Sampling Location:
City, State:
Operator's Initials:
Run Number: EX-LT-PM2.5-03-021512
Test Date: 2/15/2012
Run Time: 1110-1210

Stack Diameter (Rd): input
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> #VALUE!
Rec Area:=> 0.00
Area Used #VALUE!

Static Pressure = -1.6
Stack Temp = 80
Meter Temp = 65
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.8
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 2 ex: 1% = 1%

md= 28.84
Ps= 29.68

Mfd= 0.980
Ms= 28.62

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
2	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
3	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
4	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
5	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
6	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
7	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
8	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
9	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
10	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
11	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
12	5.0	1.2		0.57			0.0	0.000	0.000	57.9	1.095
Stop	60.0										
	Averages-->	1.20		0.57	#DIV/0!	#DIV/0!	0.00			57.89	1.10

TOTAL VOLUME = 0

Distance from far wall to outside of port	37
Nipple length and/or wall thickness	6
Depth of stack or duct	31

% of depth	distance from inside wall	distance including nipple*
2.1	0.65	6.65
6.7	2.08	8.08
11.8	3.66	9.66
17.7	5.49	11.49
25	7.75	13.75
35.6	11.04	17.04
64.4	19.96	25.96
75	23.25	29.25
82.3	25.51	31.51
88.2	27.34	33.34
93.3	28.92	34.92
97.9	30.35	36.35

* mark these points on probe

USEPA
Burn Hut #1 Exhaust Duct
RTP, NC
PM$_{2.5}$ Test Results

	RUN NUMBER	EX-LT-PM2.5-02-021412	EX-LT-PM2.5-03-021512	EX-LT-PM2.5-04-021612
	RUN DATE	2/14/2012	2/15/2012	2/16/2012
	RUN TIME	1105-1205	1110-1210	0940-1040
	MEASURED DATA			
(Y)	Meter Box Y	0.886	0.886	0.886
(DeltaH)	Avg Delta H, inches H2O	0.56	0.57	0.57
(Pbar)	Barometric Pressure, inches Hg	29.71	29.80	29.83
(Vm)	Meter Volume, ft^3	30.016	30.243	30.007
(Tm)	Avg Meter Temp, deg F	71	70	70
(Pg)	Static Pressure, inches H2O	-1.60	-1.60	-1.60
(Ts)	Avg Stack Temp, deg F	81	102	81
(Vlc)	Water Collected, mL	0.00	5.69	5.00
(%CO2)	Carbon Dioxide, %	2.0	2.0	2.0
(%O2)	Oxygen, %	17.0	17.0	17.0
(%N2)	Nitrogen, %	81.0	81.0	81.0
(Cp)	Pitot Tube Coefficient	0.84	0.84	0.84
(DeltaP)	Avg Sqrt Delta P, (inches H2O)½	1.095	1.095	1.049
(Theta)	Sample Time, min	60.0	60.0	60.0
(Dn)	Nozzle Diameter, inches	0.156	0.156	0.156
	CALCULATED DATA			
(An)	Nozzle Area, square feet	0.00013273	0.00013273	0.00013273
(Vmstd)	Standard Meter Volume, ft^3	26.309	26.618	26.412
(Ps)	Stack Pressure, inches Hg	29.59	29.68	29.71
(%H2O)	Moisture, %	1.0 *	1.0	0.9
(%H2Osat)	Moisture (at saturation), %	3.6	6.8	3.6
(Vwstd)	Standard Water Vapor Volume, ft^3	0.000	0.268	0.236
(Mfd)	Dry Mole Fraction	0.990	0.990	0.991
(Md)	Molecular Weight-dry, lb/lb-mole	29.00	29.00	29.00
(Ms)	Molecular Weight-wet, lb/lb-mole	28.89	28.89	28.90
(Vs)	Velocity, ft/s	62.6	63.7	59.8
(A)	Stack Area, ft^2	0.35	0.35	0.35
(Qa)	Volumetric flow, acfm	1,311	1,333	1,252
(Qs)	Volumetric flow, dscfm	1,252	1,231	1,202
(I)	Isokinetic Rate, %	92.1	94.8	96.3
(vis)	Stack Gas Viscocity	180.8	185.8	181.0
(sf)	Sample Flow, acfm	0.45	0.48	0.46
(cpm10)	PM10 Cut Point, microns	9.90	9.77	9.84
(cpm2.5)	PM2.5 Cut Point, microns	2.43	2.24	2.26

(continued next page)

Burn Hut #1 Exhaust Duct

$PM_{2.5}$ Test Results

(continued)

	RUN NUMBER	EX-LT-PM2.5-02-021412	EX-LT-PM2.5-03-021512	EX-LT-PM2.5-04-021612
	RUN DATE	2/14/2012	2/15/2012	2/16/2012
	RUN TIME	1105-1205	1110-1210	0940-1040
	EMISSIONS DATA			
	FILTERABLE PARTICULATE ≤ 2.5um			
(mg)	Catch, milligrams	13.0	14.9	15.5
(gr/DSCF)	Concentration, gr/DSCF	0.00762	0.00864	0.00906
(mg/DSCM)	Concentration, mg/DSCM	17.4	19.8	20.7
(lb/hr)	Emission Rate, lb/hr	0.0818	0.0911	0.0933
	FILTERABLE PARTICULATE > 2.5um			
(mg)	Catch, milligrams	3.8	3.0	2.0
(gr/DSCF)	Concentration, gr/DSCF	0.00223	0.00174	0.00117
(mg/DSCM)	Concentration, mg/DSCM	5.10	3.98	2.67
(lb/hr)	Emission Rate, lb/hr	0.0239	0.0183	0.0120
	TOTAL FILTERABLE PARTICULATE			
(mg)	Catch, milligrams	16.8	17.9	17.5
(gr/DSCF)	Concentration, gr/DSCF	0.00985	0.0104	0.0102
(mg/DSCM)	Concentration, mg/DSCM	22.5	23.7	23.4
(lb/hr)	Emission Rate, lb/hr	0.106	0.109	0.105

* Unexplained negative moisture catch. Average of third and fourth runs used.

BAROMETRIC PRESSURE, in. Hg = 29.71
STACK STATIC PRESSURE, in. H2O = -1.6
AVG. STACK TEMPERATURE, deg. F = 80
METER TEMPERATURE, deg. F 60
ORIFICE DELTA H@, in H20 = 1.77

%CO2 = 2
%O2 = 17
%N2+%CC 81
MOISTURE FRACTIC 0.02 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	80	130	30
DELTA H, IN H2O	0.563038	0.571648	0.556515

MW (DRY)	29.00		
MW (WET)	28.78		
PS=	29.59235		
VIS=	180.59	193.69	167.66
CYC FLOV	0.4479	0.4931	0.4041

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	56.24852	46.81317	39.99603	34.5664	31.04	28.28231
MIN VEL ft/sec	40.94941	32.90201	26.92826	21.98672	18.61281	15.80393
MAX VEL ft/sec	70.1944	59.10346	51.13072	44.8143	40.73256	37.55443
DEL. P MIN in. H2O	0.512968	0.331161	0.221825	0.147882	0.105979	0.076405
DEL. P MAX in. H2O	1.507299	1.068613	0.799757	0.614367	0.507549	0.431436

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.20	60.0	60.0	80
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	1.200	60.0		80

BAROMETRIC PRESSURE, in. Hg	=	29.8
STACK STATIC PRESSURE, in. H2O	=	-1.6
AVG. STACK TEMPERATURE, deg. F	=	80
METER TEMPERATURE, deg. F		65
ORIFICE DELTA H@, in H20	=	1.77
%CO2	=	2
%O2	=	17
%N2+%CC		81
MOISTURE FRACTIC		0.02 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	80	130	30
DELTA H, IN H2O	0.569167	0.577871	0.562573

MW (DRY)	29.00		
MW (WET	28.78		
PS=	29.68235		
VIS=	180.59	193.69	167.66
CYC FLO	0.4475	0.4927	0.4037

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	56.19817	46.77127	39.96022	34.53546	31.01221	28.257
MIN VEL ft/sec	40.90887	32.86806	26.89895	21.96091	18.58901	15.78132
MAX VEL ft/sec	70.13391	59.05307	51.08762	44.777	40.69901	37.52381
DEL. P MIN in. H2O	0.513509	0.331483	0.222016	0.147984	0.106029	0.076419
DEL. P MAX in. H2O	1.509279	1.070036	0.800838	0.61521	0.508254	0.432043

TOTAL RUN TIME, min.	=	60
NUMBER OF TRAVERSE POIN		1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.20	60.0	60.0	80
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	1.200	60.0		80

BAROMETRIC PRESSURE, in. Hg = 29.83
STACK STATIC PRESSURE, in. H2O = -1.6
AVG. STACK TEMPERATURE, deg. F = 80
METER TEMPERATURE, deg. F 65
ORIFICE DELTA H@, in H20 = 1.77
%CO2 = 2
%O2 = 17
%N2+%CC 81
MOISTURE FRACTIC 0.02 ex: 1% = 0.01

NOZZLE SPECS.

NOZZLE	DIA in.	METH 201A Cp	METH. 2 Cp
1	0.156	0.84	0.84
2	0.171	0.84	0.84
3	0.185	0.84	0.84
4	0.199	0.84	0.84
5	0.21	0.84	0.84
6	0.22	0.84	0.84

Red = Calculated/Protected Items

STACK TEMP, deg. F	80	130	30
DELTA H, IN H2O	0.569406	0.578113	0.562808

MW (DRY)	29.00		
MW (WET	28.78		
PS=	29.71235		
VIS=	180.59	193.69	167.66
CYC FLO	0.4474	0.4925	0.4036

NOTE: DO NOT USE ANY NOZZLE WHERE "MIN VEL" OR "DEL. P MIN" SHOWS "#NUM!"

NOZZLE	1	2	3	4	5	6
DIAMETER	0.156	0.171	0.185	0.199	0.21	0.22
NOZZLE VEL ft/sec	56.18143	46.75734	39.94832	34.52517	31.00298	28.24858
MIN VEL ft/sec	40.89539	32.85677	26.88921	21.95232	18.5811	15.7738
MAX VEL ft/sec	70.1138	59.03632	51.0733	44.7646	40.68786	37.51363
DEL. P MIN in. H2O	0.513689	0.33159	0.222079	0.148017	0.106046	0.076423
DEL. P MAX in. H2O	1.509938	1.07051	0.801198	0.615491	0.508489	0.432245

TOTAL RUN TIME, min. = 60
NUMBER OF TRAVERSE POINT 1

Point #	DEL. P	Minutes/ Point	Running Time	Stack Temp
1	1.20	60.0	60.0	80
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
1		0.0	60.0	input
2		0.0	60.0	input
3		0.0	60.0	input
4		0.0	60.0	input
5		0.0	60.0	input
6		0.0	60.0	input
7		0.0	60.0	input
8		0.0	60.0	input
9		0.0	60.0	input
10		0.0	60.0	input
11		0.0	60.0	input
12		0.0	60.0	input
AVG DEL I	1.200	60.0		80

Blue = Input Items
Red = Calculated/Protected Items

Facility Name: USEPA
Sampling Location: Burn Hut #1 Exhaust Duc
City, State: RTP, NC
Operator's Initials:
Run Number: EX-LT-PM2.5-02-021412
Test Date: 2/14/2012
Run Time: 1105-1205

Stack Diameter (Rd): 8
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> 0.35
Rec Area:=> 0.00
Area Used 0.349066

Static Pressure = -1.6
Stack Temp = 80
Meter Temp = 60
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.71
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 2 ex: 1% = 1%

md= 28.84
Ps= 29.59

Mfd= 0.980
Ms= 28.62

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1.2	569.764	0.56	60	67	90.5	2.476	2.185	61.6	1.095
2	5.0	1.2	572.24	0.56	71	67	90.9	2.460	2.171	62.3	1.095
3	5.0	1.2	574.7	0.56	74	67	92.2	2.490	2.197	62.5	1.095
4	5.0	1.2	577.19	0.56	79	68	92.8	2.500	2.202	62.8	1.095
5	5.0	1.2	579.69	0.56	79	69	92.7	2.500	2.197	62.8	1.095
6	5.0	1.2	582.19	0.56	82	70	93.1	2.510	2.202	62.9	1.095
7	5.0	1.2	584.7	0.56	82	71	92.9	2.510	2.198	62.9	1.095
8	5.0	1.2	587.21	0.56	88	72	92.5	2.490	2.176	63.3	1.095
9	5.0	1.2	589.7	0.56	87	73	93.8	2.530	2.207	63.2	1.095
10	5.0	1.2	592.23	0.56	87	73	93.4	2.520	2.198	63.2	1.095
11	5.0	1.2	594.75	0.56	89	74	93.4	2.520	2.194	63.3	1.095
12	5.0	1.2	597.27	0.56	93	75	93.2	2.510	2.182	63.6	1.095
	60.0		599.78								
Averages-->		1.20		0.56	80.92	70.50	92.62			62.87	1.10

TOTAL VOLUME = 30.016

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:
Sampling Location:
City, State:
Operator's Initials:
Run Number: EX-LT-PM2.5-03-021512
Test Date: 2/15/2012
Run Time: 1110-1210

Stack Diameter (Rd): input
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> #VALUE!
Rec Area:=> 0.00
Area Used #VALUE!

Static Pressure = -1.6
Stack Temp = 80
Meter Temp = 65
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.8
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 2 ex: 1% = 1%

md= 28.84
Ps= 29.68

Mfd= 0.980
Ms= 28.62

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Average Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1.2	599.894	0.57	91	66	96.1	2.546	2.258	63.4	1.095
2	5.0	1.2	602.44	0.57	91	66	92.9	2.460	2.181	63.4	1.095
3	5.0	1.2	604.9	0.57	90	67	94.9	2.520	2.230	63.3	1.095
4	5.0	1.2	607.42	0.57	92	68	94.9	2.520	2.226	63.4	1.095
5	5.0	1.2	609.94	0.57	91	68	94.0	2.500	2.208	63.4	1.095
6	5.0	1.2	612.44	0.57	103	69	95.6	2.520	2.222	64.0	1.095
7	5.0	1.2	614.96	0.57	106	70	96.8	2.550	2.244	64.2	1.095
8	5.0	1.2	617.51	0.57	106	71	95.5	2.520	2.213	64.2	1.095
9	5.0	1.2	620.03	0.57	111	72	96.1	2.530	2.218	64.5	1.095
10	5.0	1.2	622.56	0.57	116	73	97.5	2.560	2.240	64.8	1.095
11	5.0	1.2	625.12	0.57	110	74	94.9	2.510	2.192	64.4	1.095
12	5.0	1.2	627.63	0.57	111	75	94.7	2.507	2.186	64.5	1.095
Stop	60.0		630.137								
	Averages-->	1.20		0.57	101.50	69.92	95.33			63.95	1.10

TOTAL VOLUME = 30.243

Blue = Input Items
Red = Calculated/Protected Items

Facility Name:
Sampling Location:
City, State:
Operator's Initials:
Run Number: EX-LT-PM2.5-04-021612
Test Date: 2/16/2012
Run Time: 0940-1040

Stack Diameter (Rd): input
Stack Dimension (Rec):
Width 0
Depth 0

Rd Area:=> #VALUE!
Rec Area:=> 0.00
Area Used #VALUE!

md= 28.84
Ps= 29.71

Mfd= 0.980
Ms= 28.62

Static Pressure = -1.6
Stack Temp = 80
Meter Temp = 65
CO2 = 0
O2 = 20.9
Barometric Pres. = 29.83
Pitot Coefficient = 0.84
Actual Nozzle = 0.156
Meter Box Gamma = 0.886
Moisture % = 2 ex: 1% = 1%

Sample Point	Minutes/ Point	Pitot Reading	Dry Gas Meter Reading	Delta H	Flue Gas Temp.	Outlet Meter Temp.	% Iso	Volume Metered	Volume Metered Standard	Velocity (vs)	Square Root Delta P
1	5.0	1.1	630.32	0.57	64	67	95.2	2.480	2.197	59.1	1.049
2	5.0	1.1	632.8	0.57	65	67	96.1	2.500	2.215	59.2	1.049
3	5.0	1.1	635.3	0.57	80	68	97.7	2.510	2.219	60.0	1.049
4	5.0	1.1	637.81	0.57	79	68	96.4	2.480	2.193	60.0	1.049
5	5.0	1.1	640.29	0.57	82	69	96.9	2.490	2.198	60.1	1.049
6	5.0	1.1	642.78	0.57	83	70	97.6	2.510	2.211	60.2	1.049
7	5.0	1.1	645.29	0.57	84	71	97.5	2.510	2.207	60.2	1.049
8	5.0	1.1	647.8	0.57	85	72	97.4	2.510	2.203	60.3	1.049
9	5.0	1.1	650.31	0.57	87	72	97.2	2.500	2.194	60.4	1.049
10	5.0	1.1	652.81	0.57	88	73	97.1	2.500	2.190	60.5	1.049
11	5.0	1.1	655.31	0.57	86	74	97.5	2.520	2.203	60.4	1.049
12	5.0	1.1	657.83	0.57	93	74	97.2	2.497	2.183	60.7	1.049
Stop	60.0		660.327								
	Averages-->	1.10		0.57	81.33	70.42	96.96			60.09	1.05

TOTAL VOLUME = 30.007

Distance from far wall to outside of port	37
Nipple length and/or wall thickness	6
Depth of stack or duct	31

% of depth	distance from inside wall	distance including nipple*
2.1	0.65	6.65
6.7	2.08	8.08
11.8	3.66	9.66
17.7	5.49	11.49
25	7.75	13.75
35.6	11.04	17.04
64.4	19.96	25.96
75	23.25	29.25
82.3	25.51	31.51
88.2	27.34	33.34
93.3	28.92	34.92
97.9	30.35	36.35

* mark these points on probe

APPENDIX D

Asbestos Analytical Results

INTERNAL CHAIN OF CUSTODY

1/17/2012 12:14:36 PM

Order ID: 271200007

Attn:	Robert Marriam Remedium Group, Inc. Subsidiary of W.R. Grace 6401 Poplar Avenue, Suite 301 Memphis, TN 38119	Customer ID:	REME44
		Customer PO:	
		Received:	01/11/12 10:09 AM
Fax:	(901) 820-2061 Phone: (901) 820-2023	EMSL Order:	271200007
Project:	**RN990272.0003** **Samples collected 12/15, 28, 29/2012**	EMSL Proj ID:	Burn House
		Cust COC ID	

Test: **TEM ISO 10312** **Matrix** Air **TAT:** 96 Hour **Qty:** 3

Acct Sts: N30 **Slsprsn:** rdemalo **Logged:** rmahoney **Date:** 1/11/2012

Inter- Lab Sample Transfer

Samples Relinquished: Date

Samples Received: Date

Package Mailed to Westmont: Date

Method of Delivery:

Includes: (Circle)

Benchsheets Sample Slides Sample filters
Micrographs GridBox Other

Final Package Received: Date:

Sample Condition: ☒ Acceptable ☐ Unacceptable

Comments

Initial Prep (Initials/Lab): DB **Date:** 1/12/12
Filter Prep (Initials/Lab): DB **Date:** 1/12/12
Grid Prep (Initials/Lab): DB **Date:** 1/12/12

For Special Projects Use Only

QC Selection: Date:
Date Package Review: Date:
Date Package Mailed: Date:

Special Instructions

Order ID	Lab Sample #	Cust. Sample #	Location	Due Date
271200007	271200007-0001	EX-IMP Hot Blank-01-		1/17/2012 10:09:55 AM
271200007	271200007-0002	EX -HT-IMP -03-12281		1/17/2012 10:09:55 AM
271200007	271200007-0003	EX-IMP Hot Blank-02-		1/17/2012 10:09:55 AM

2712-REM-10

CHAIN OF CUSTODY RECORD

271200007

Project Name	USEPA
Project Location	RTP, NC
Sampling Location	Burn Hut #1 Outlet Duct
Project Number	RN990272.0003
Laboratory	EMSL Analytical, Inc.
Laboratory P.O. #	

Sample ID	Sample Matrix	Analysis Requested
EX-IMP Hot Blank-01-121511 64.005 dry standard cubic feet	Impinger DI H2O and DI H2O Rinse	asbestos
EX-HT-IMP-03-122811 36.707 dry standard cubic feet	Impinger DI H2O and DI H2O Rinse	asbestos
EX-IMP Hot Blank-02-122911 37.455 dry standard cubic feet	Impinger DI H2O and DI H2O Rinse	asbestos

Notes/Comments:

Relinquished By:	Daniel	Relinquished By:	
Date/Time:	12/30/2011	Date/Time:	
Received By:	R Beleole	Received By:	K Bleakley-EMSL
Date/Time:	12 30 11	Date/Time:	1/3/2012 8:30

ARCADIS U.S., Inc.
4915 Prospectus Drive, Suite F
Durham, North Carolina 27713

Phone Number: (919) 544-4535
Fax Number: (919) 544-5690

Relinquished: Keri Bleakley
Date: 1/5/12 11:00

Rec'd R K Mahoney EMSL 1/10/12 1410

Sample Volumes

Standard Conditions of 68°F and 29.92 inches Hg

Run #	Sample Volume, dscf	Sample Volume, dsl
EX-PM2.5 Hot Blank-01-121511	27.438	776.96
EX-PM Hot Blank-01-121511	64.162	1816.87
EX-IMP Hot Blank-01-121511	64.083	1814.63
EX-MCE Hot Blank-01A-121511	5.526	156.54
EX-HT-PM2.5-01-121911	26.527	751.16
EX-HT-PM-01-121911	43.422	1229.57
EX-HT-IMP-01-121911	42.102	1192.20
EX-HT-MCE-01A-121911	2.703	76.56
EX-HT-MCE-01B-121911	2.670	75.64
EX-HT-MCE-01C-121911	2.599	73.63
EX-HT-MCE-01D-121911	2.667	75.55
EX-HT-PM2.5-02-122211	26.598	753.17
EX-HT-PM-02-122211	39.202	1110.08
EX-HT-IMP-02-122211	39.795	1126.87
EX-HT-MCE-02A-122211	2.643	74.87
EX-HT-MCE-02B-122211	2.786	78.92
EX-HT-MCE-02C-122211	2.681	75.95
EX-HT-MCE-02D-122211	2.916	82.62
EX-HT-PM2.5-03-122811	27.171	769.40
EX-HT-PM-03-122811	39.544	1119.76
EX-HT-IMP-03-122811	36.673	1038.46
EX-HT-MCE-03A-122811	1.710	48.44
EX-HT-MCE-03B-122811	2.668	75.58
EX-HT-MCE-03C-122811	2.779	78.72
EX-HT-MCE-03D-122811	2.498	70.76
EX-PM2.5 Hot Blank-02-122911	26.713	756.43
EX-PM Hot Blank-02-122911	39.214	1110.42
EX-IMP Hot Blank-02-122911	37.467	1060.95
EX-MCE Hot Blank-02A-122911	11.191	317.03

EMSL27 WATER PREPARATION RECORD

EMSL Analytical Inc., Libby, MT

Order ID: 271200067
Date Received: 1/11/2012
EFA (mm²): 1285
Filter Lot #: 0661420O
Prepared by: DB
Date: 1/16/2012

Sample #	Temperature at Receipt (Optional)	Volume Received (Optional)	Sample Processing				Filtration			Serial Dilution								Remaining Volume	
										First Dilution				Second Dilution					
			Processing Date	UV	Ozonation	Total Sonication Time	Filtration Date	Volume Filtered	Prepared for Analysis	Vol. of original sample used	Resuspend volume	Volume Filtered	Prepared for Analysis	Vol of 1st Dilution used	Resuspend volume	Volume Filtered	Prepared for Analysis	Filter Date	Volume
	°C	mL		Y/N	Y/N	min		mL	Y/N	mL	mL	mL	Y/N	mL	mL	mL	Y/N		mL
EX-IMP-HOT BLANK-01-121511			1/16/12	Y	Y	15	1/16/12	380	Y										
EX-IMP-HOT BLANK-02-122011			1/16/12	Y	Y	15	1/16/12	330	Y										
MB			–	–	–	–	1/16/12	100	Y										

1/17/2012
DB

Filter Type: [✓ MCE] or PC
Filter Pore Size: 0.2 µm
Backing Filter Pore Size: 5 µm

EMSL27 WATER PREPARATION RECORD

EMSL Analytical Inc., Libby, MT

Order ID: 271200007
Date Received: 1/11/2012
EFA (mm²): 360
Filter Lot #:
Prepared by: DB
Date: 1/16/2012

Sample #	Temperature at Receipt (Optional)	Volume Received (Optional)	Sample Processing				Filtration			Serial Dilution								Remaining Volume	
										Ashed First Dilution				Second Dilution					
			Processing Date	UV	Ozonation	Total Sonication Time	Filtration Date	Volume Filtered	Prepared for Analysis	Vol. of original sample used	Resuspend volume	Volume Filtered	Prepared for Analysis	Vol of 1st Dilution used	Resuspend volume	Volume Filtered	Prepared for Analysis	Filter Date	Volume
	°C	mL		Y/N	Y/N	min		mL	Y/N	mL	mL	mL	Y/N	mL	mL	mL	Y/N		mL
GX-HT-IMP-03 122811			1/16/12	Y	Y	15	1/16/12	425	N	425	100	20	Y						
AB										—	100	100	Y						
									DB										
									1/17/2012										
Air impinger samples																			

Filter Type: MCE or [✓ PC]   **Filter Pore Size:** ~~0.2 µm~~ 0.1 µm   **Backing Filter Pore Size:** ~~5 µm~~ 0.45 µm

Locally Controlled Document
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EX-HT-IMP-03-122811

Marked water level on Jar

Ran ozone and uv for 23 min

Sonicated for 15 min

Filtered onto 0.2µm - lot No. 00614200

Estimated Volume to water level Mark on Jar ~ 425mL

Dried Filter - Filter was overloaded

Ashed Sample - whole filter was used

Resuspended sample to 100mL PH Adjusted between 5-4

Sonicated for 15min

Took 10mL From the First Resuspension and made a First -
- Dilution of 100mL

Filtered 20mL From the First Dilution onto 0.1µm PC Filter -
- lot No. 147425

Dried Filter

Carbon coated Filter

Cleared by Chatfield on 10x10 Wdex grids.

Prep Notes for Internal COC 271200007

Prepd the same Method

Ex-IMP Hot Blank-01-121511 ↔ Ex-IMP Hot Blank-02-122911

Marked water level on Jars

Ran ozone and UV for 23min for Each sample

Sonicated Both samples for 15min

Filtered onto 0.2μm - lot No. 006/4200

Estimated volumes in Jars to the marked line

Ex-IMP Hot Blank-01-121511 ~ 380mL
Ex-IMP Hot Blank-02-122911 ~ 330mL

Dried Filters - Direct Prep for Both

~~Collapsed Filter~~

DP 1/18/2012

Cut and collapsed small portion of each filter onto a slide

DMF was used to collapse the filters

Plasma etched filters for 5% Reduction

Carbon coated filters

Cleared by Acetone on 10x10 index grids

Page 1 of ___

Remedium - USEPA Region 8 Libby Site OU3 Investigation v33
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	1295
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.8

EPA Sample Number:	EX-IMP-Hot Blank-01-121511
Sample Type (A=Air, D=Dust, DF = Dustfall):	A
Air volume (L), dust area (cm2), or dustfall container area (cm2)	1812.4 ~~64.005~~
Date received by lab	3 1/~~10~~/2012
Lab Job Number:	271200007
Lab Sample Number:	271200007-0001
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	1/12/2012
EPA COC Number:	RN990272.0003
Secondary filter pore size (um)	0.2

1/20/12

Analyzed by	R. Pescador
Analysis date	1/16/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	No
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-10
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right----->

Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

Minimum Width (um): None

Stopping Rules:

Target Sensitivity: ___

Max # of GOs: ___

Target # of Structures: 50

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
A1	D2	nd														
	D4	nd														
	D6	nd														
	D8	nd														
	D10	nd														
A3	D2	nd														
	D4	nd														
	D6	nd														
	D8	nd														
	D10	nd														

F-factor Calculation:

Indirect Prep Inputs

	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
	First resuspension volume or rinsate volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

LA = Libby-type amphibole   OA = Other (non-Libby type) amphibole   C = Chrysotile   NAM = Non-asbestos material

Grid opening traverse direction (circle one)
H Horizontal
[✓ V] Vertical

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

If No, explain: ___

Remedium - USEPA Region 8 Libby Site OU3 Investigation v33
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	1295
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.8

EPA Sample Number:	EX-HT-IMP-03-122811
Sample Type (A=Air, D=Dust, DF = Dustfall):	A
Air volume (L), dust area (cm2), or dustfall container area (cm2)	1039.4 ~~26.707~~
Date received by lab	7 1/10/2012
Lab Job Number:	271200007 ~~78~~ M 1/16/12
Lab Sample Number:	271200007-0002
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	1/12/2012
EPA COC Number:	RN990272.0003
Secondary filter pore size (um)	0.1

Analyzed by	R. Pescador
Analysis date	1/16/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	IA
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	No
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-10
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right----->

Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

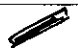
Minimum Width (um): None

Stopping Rules:

Target Sensitivity:

Max # of GOs: 4

Target # of Structures: 50

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
B2	A5	F	1	1	1.15	0.25	ADX	1				 Nak/ WRTA	1	27091 27092	1	
		F	2	2	9.75	0.85	ADX	1				 Nak/ WRTA	1	27093 27094	1	
		F	3	3	1.20	0.20	ADX	1				 Nak/ WRTA	1	27095 27096	1	
		F	4	4	1.75	0.40	ADX	1				 Nak/ WRTA	1	27097 27098	1	
		F	5	5	3.25	0.35	ADX	1				 Nak/ WRTA	1	27099 27100	1	
		F	6	6	0.90	0.15	ADX	1				 Nak/ WRTA	1			
		F	7	7	2.80	0.20	ADX	1				 Nak/ WRTA	1			
	B7	F	8	8	1.30	0.15	ADX	1				 Nak/ WRTA	1			
		F	9	9	0.90	0.25	ADX	1				 Nak/ WRTA	1			
		F	10	10	1.25	0.10	ADX	1				 Nak/ WRTA	1			

F-factor Calculation:

Indirect Prep Inputs

1.0	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
100	First resuspension volume or rinsate volume (mL)
10	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

100	Second resuspension volume (mL)
20	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

LA = Libby-type amphibole

OA = Other (non-Libby type) amphibole

C = Chrysotile

NAM = Non-asbestos material

Grid opening traverse direction (circle one):

H Horizontal

[✓ V] Vertical

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

If No, explain:

Remedium - USEPA Region 8 Libby Site OU3 Investigation v33
TEM Asbestos Structure Count

LAB NAME	EMSL27	EPA SAMPLE NO.	EX-HT-IMP-03-122811	QA TYPE		LAB JOB NUMBER	271200007 ~~76~~ /R 1/16/12
LAB SAMPLE NO.	271200007-0002	SAMPLE TYPE	A		Not QA	GRID STORAGE LOC.	2712-REM-10

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
B2	37	F	11	11	4.75	0.20	ADX	1				 Nak/ WRTX	1			
		F	12	12	5.0	0.20	ADX	1				 Nak/ WRTX	1			
		F	13	13	3.20	0.15	ADX	1				 Nak/ WRTX	1			
		F	14	14	8.25	0.25	ADX	1				 Nak/ WRTX	1			
		F	15	15	1.90	0.35	ADX	1				 Nak/ WRTX	1			
		F	16	16	6.0	0.20	ADX	1				 Nak/ WRTX	1			
		F	17	17	1.30	0.25	ADX	1				 Nak/ WRTX	1			
		F	18	18	2.65	0.25	ADX	1				 Nak/ WRTX	1			
	D6	F	19	19	0.80	0.20	ADX	1				 Nak/ WRTX	1			
		F	20	20	4.50	0.15	ADX	1				 Nak/ WRTX	1			
		F	21	21	1.25	0.25	ADX	1				 Nak/ WRTX	1			
		F	22	22	2.55	0.25	ADX	1				 Nak/ WRTX	1			
		F	23	23	2.90	0.30	ADX	1				 Nak/ WRTX	1			
		F	24	24	1.10	0.15	ADX	1				 Nak/ WRTX	1			
		B	25	25	2.85	0.50	ADX	1				 Nak/ WRTX	1			

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Remedium - USEPA Region 8 Libby Site OU3 Investigation v33

TEM Asbestos Structure Count

LAB NAME	EMSL27	EPA SAMPLE NO.	EX-HT-IMP-03-122811	QA TYPE	LAB JOB NUMBER 2712000070 M 1/11/12
LAB SAMPLE NO.	271200007-0002	SAMPLE TYPE	A	Not QA	GRID STORAGE LOC. 2712-REM-10

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
B2	D8	B	26	26	18.25	0.50	ADX	1				 Nal/ WRTA	1			
		F	27	27	0.85	0.15	ADX	1				 Nal/ WRTA	1			
		F	28	28	1.0	0.20	ADX	1				 Nal/ WRTA	1			
		F	29	29	5.50	0.75	ADX	1				 Nal/ WRTA	1			
B4	B8	F	30	30	0.75	0.20	ADX	1				 Nal/ WRTA	1			
		F	31	31	1.20	0.20	ADX	1				 Nal/ WRTA	1			
		F	32	32	17.0	0.50	ADX	1				 Nal/ WRTA	1			
		F	33	33	1.50	0.10	ADX	1				 Nal/ WRTA	1			
	E7	F	34	34	28.75	0.65	ADX	1				 Nal/ WRTA	1			
		B	35	35	35.25	3.0	ADX	1				 Nal/ WRTA	1			
		F	36	36	0.75	0.10	ADX	1				 Nal/ WRTA	1			
		F	37	37	0.75	0.15	ADX	1				 Nal/ WRTA	1			
		F	38	38	0.70	0.15	ADX	1				 Ncl/ WRTA	1			
		F	39	39	1.25	0.30	ADX	1				 Nal/ WRTA	1			
		F	40	40	1.15	0.20	ADX	1				 Nal/ WRTA	1			

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Remedium - USEPA Region 8 Libby Site OU3 Investigation v33

TEM Asbestos Structure Count

LAB NAME	EMSL27	EPA SAMPLE NO.	EX-HT-IMP-03-122811	QA TYPE		LAB JOB NUMBER	27120007~~6~~ 1/16/12
LAB SAMPLE NO.	271200007-0002	SAMPLE TYPE	A		Not QA	GRID STORAGE LOC.	2712-REM-10

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
B4	~~B E7~~ 1/16/12	F	41	41	5.50	0.50	ADX	1				 NaK/ WRTA	1			
		F	42	42	5.25	0.90	ADX	1				 NaK/ WRTA	1			
		F	43	43	0.80	0.15	ADX	1				 NaK/ WRTA	1			
		F	44	44	1.50	0.20	ADX	1				 NaK/ WRTA	1			
	G8	F	45	45	0.90	0.25	ADX	1				 NaK/ WRTA	1			
		F	46	46	3.50	0.25	ADX	1				 NaK/ WRTA	1			
		F	47	47	3.0	0.25	ADX	1				 NaK/ WRTA	1			
		F	48	48	23.10	0.75	ADX	1				 NaK/ WRTA	1			
		F	49	49	47.0	1.15	ADX	1				 NaK/ WRTA	1			
		F	50	50	6.25	0.10	ADX	1					1			
		F	51	51	1.50	0.15	ADX	1				 NaK/ WRTA	1			

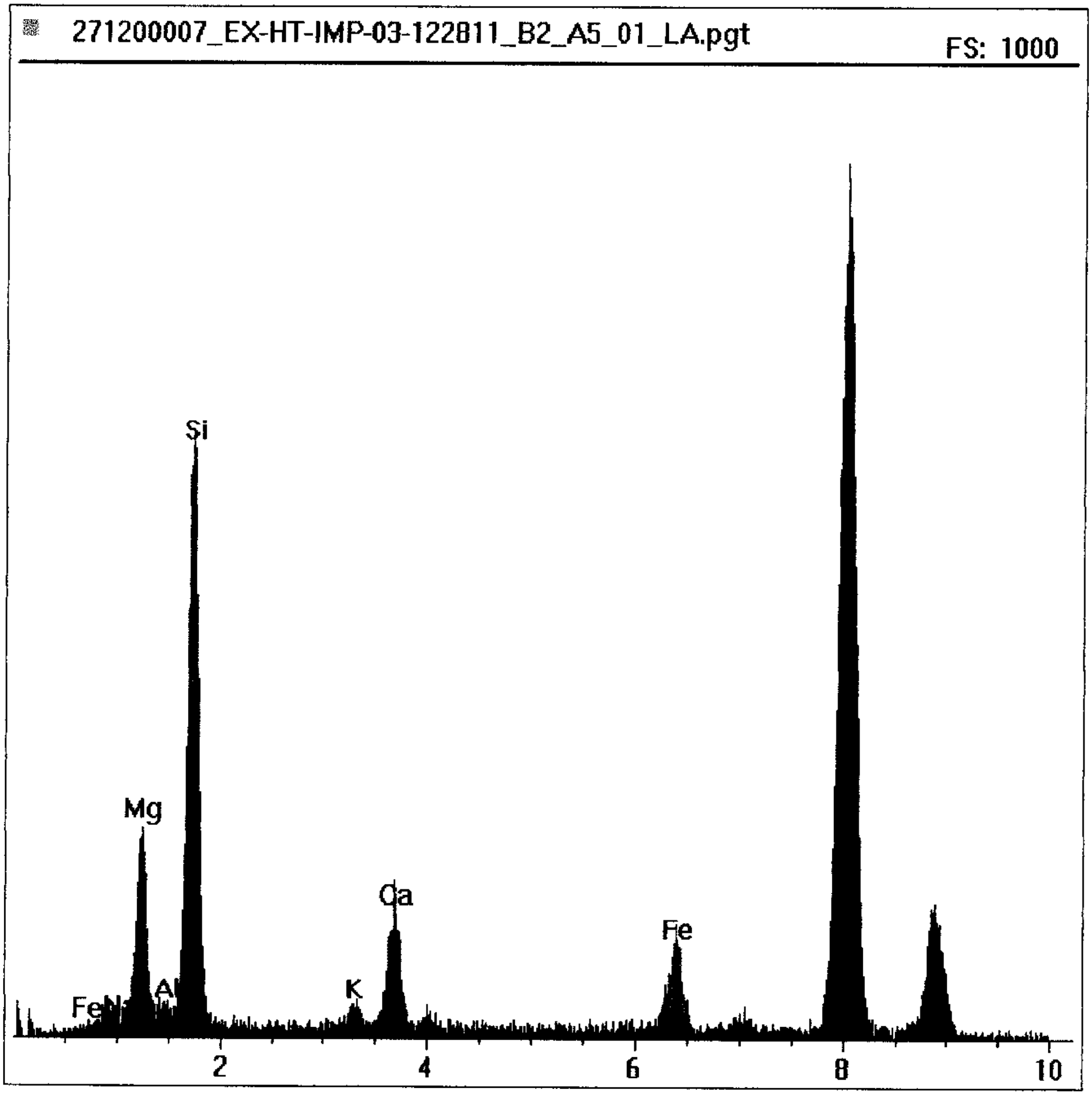
1/16/12

Energy Dispersive X-Ray Analysis Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...7-2 2012\271200007_EX-HT-IMP-03-122811_B2_A5_01_LA.pgt
Collected: January 16, 2012 10:22:32

Live Time: 116.55 Count Rate: 1485 Dead Time: 40.17 %
Beam Voltage: 20.00 Beam Current: 2.00 Takeoff Angle: 57.98

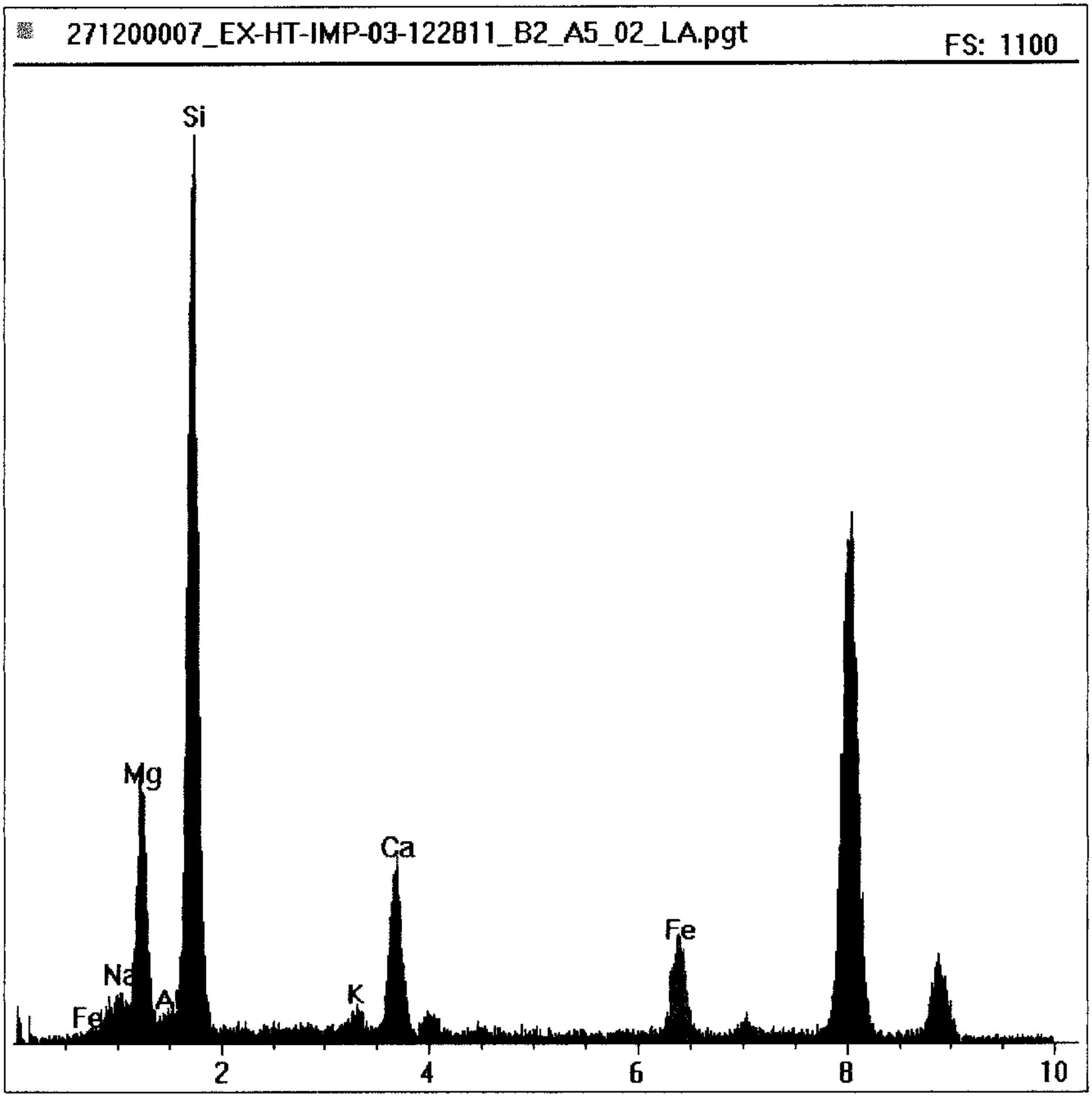


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...7-2 2012\271200007_EX-HT-IMP-03-122811_B2_A5_02_LA.pgt
Collected: January 16, 2012 10:22:32

Live Time:	59.84	Count Rate:	3024	Dead Time:	47.79 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

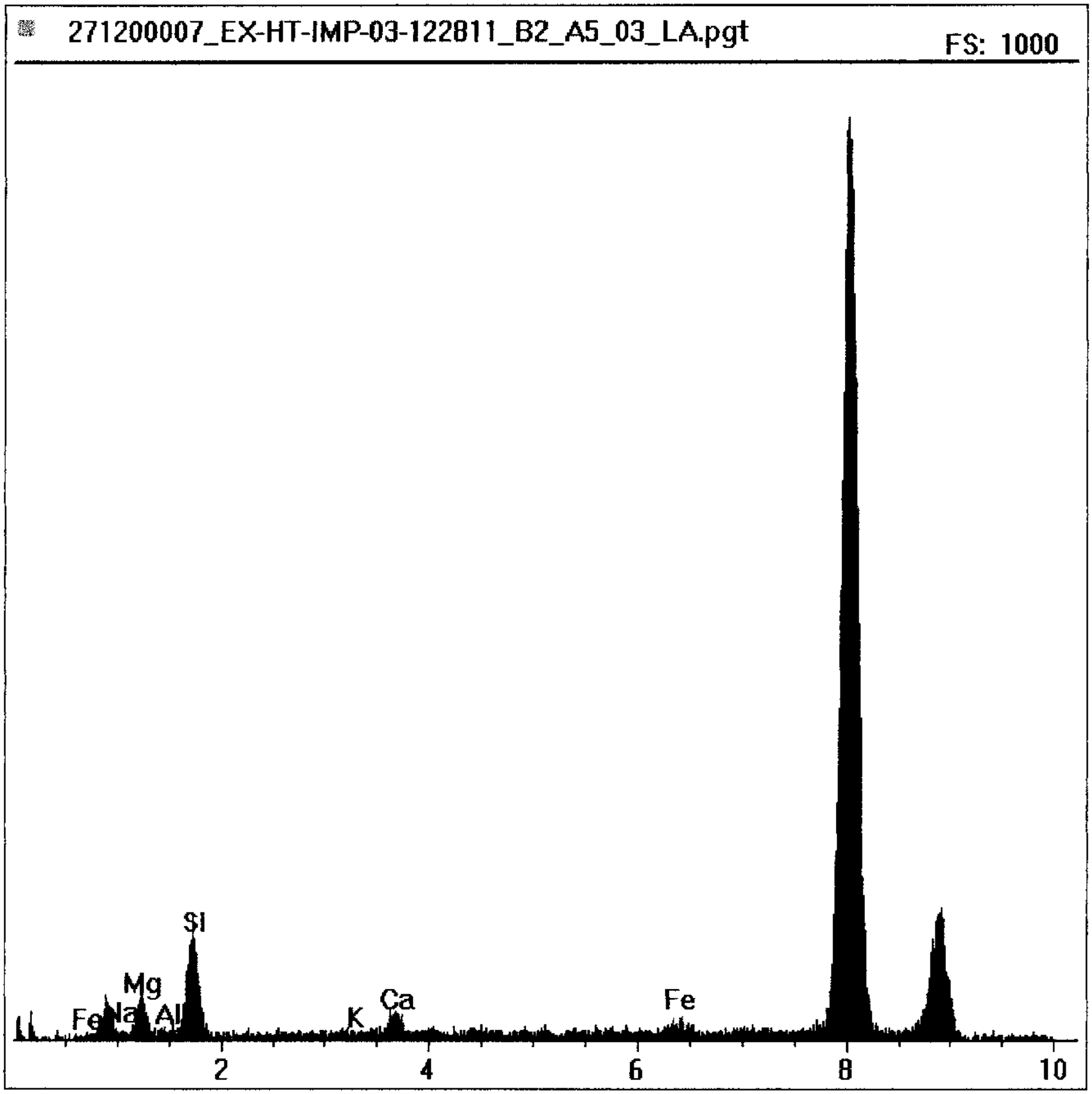


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...7-2 2012\271200007_EX-HT-IMP-03-122811_B2_A5_03_LA.pgt
Collected: January 16, 2012 10:22:32

Live Time:	120.90	Count Rate:	949	Dead Time:	37.78 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

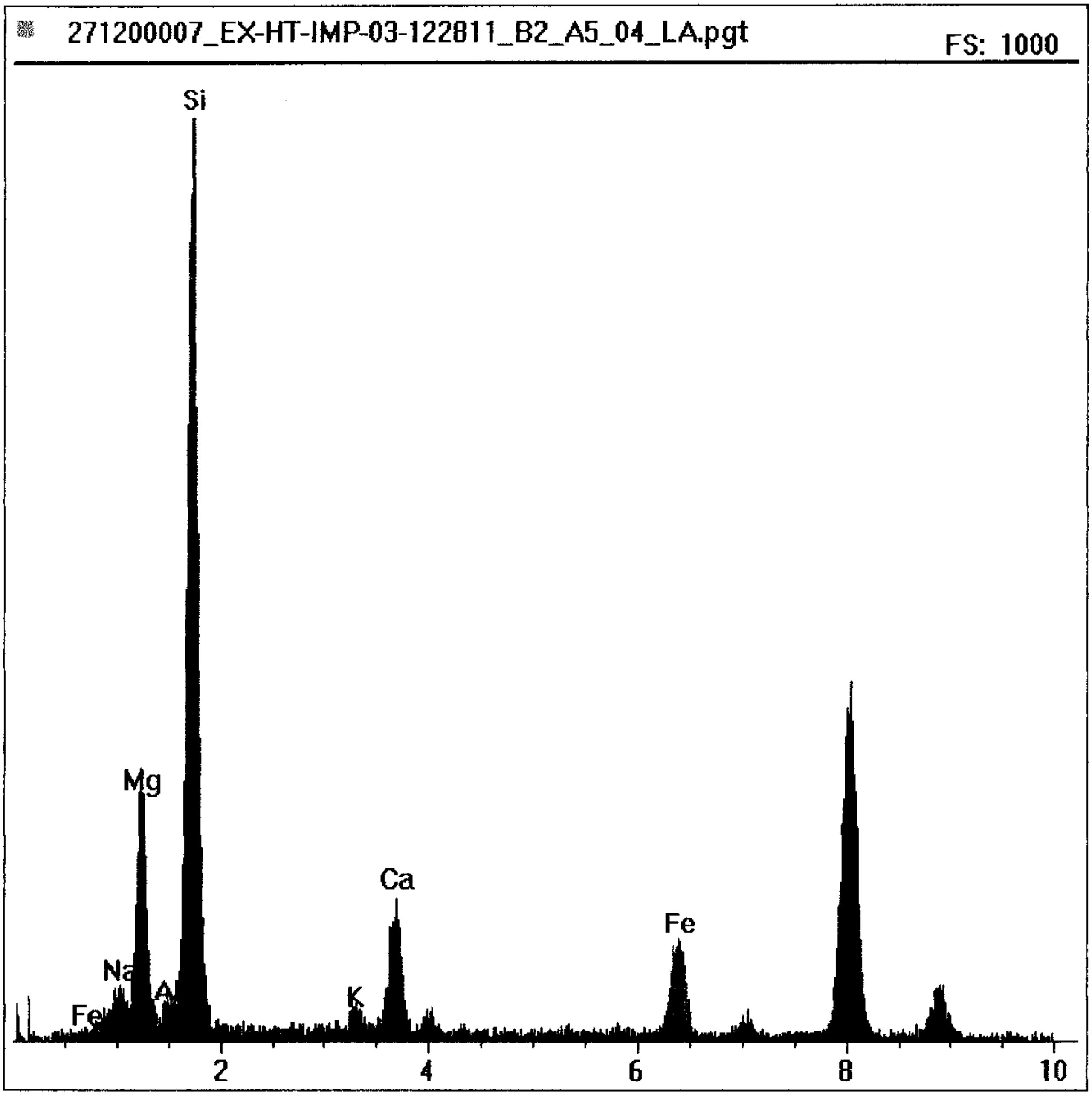


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...7-2 2012\271200007_EX-HT-IMP-03-122811_B2_A5_04_LA.pgt
Collected: January 16, 2012 10:22:32

Live Time:	103.04	Count Rate:	1388	Dead Time:	38.64 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

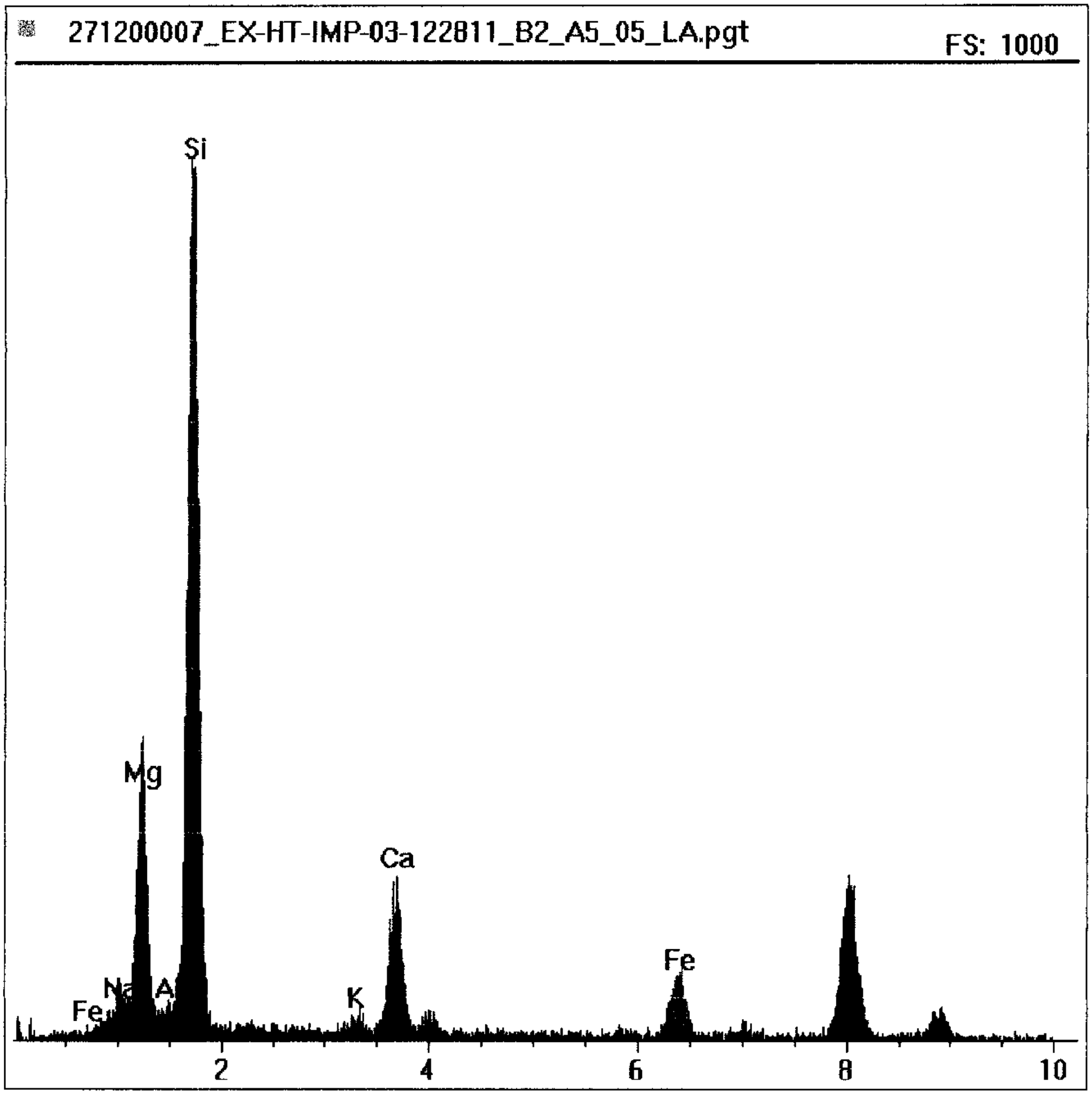


EMSL ANALYTICAL, INC.

Energy Dispersive X-Ray Analysis
Qualitative Spectrum

File: F:\Documen...7-2 2012\271200007_EX-HT-IMP-03-122811_B2_A5_05_LA.pgt
Collected: January 16, 2012 10:22:32

Live Time:	120.80	Count Rate:	1018	Dead Time:	38.74 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98



Remedium - USEPA Region 8 Libby Site OU3 Investigation v33
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	1295
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.8

EPA Sample Number:	EX-IMP-Hot Blank-02 122911
Sample Type (A=Air, D=Dust, DF = Dustfall):	A
Air volume (L), dust area (cm2), or dustfall container area (cm2)	1060.6 37.455
Date received by lab	3 1/~~10~~/2012
Lab Job Number:	271200007
Lab Sample Number:	271200007-0003
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	1/12/2012
EPA COC Number:	RN990272.0003
Secondary filter pore size (um)	0.2

1/16/12

Analyzed by	R. Pescador
Analysis date	1/16/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	No
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-10
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right----->

Recording Rules:

Minimum Aspect Ratio (circle one):

none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

Minimum Width (um): None

Stopping Rules:

Target Sensitivity: ______

Max # of GOs: ______

Target # of Structures: 50

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
C1	C1	nd														
	C3	nd														
	C5	nd														
	C7	nd														
	C9	nd														
C3	C2	nd														
	C4	nd														
	C6	nd														
	C8	nd														
	C10	nd														

F-factor Calculation:

Indirect Prep Inputs

	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
	First resuspension volume or rinsate volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

LA = Libby-type amphibole OA = Other (non-Libby type) amphibole C = Chrysotile NAM = Non-asbestos material

Grid opening traverse direction (circle one):
H Horizontal
[✓ V] Vertical

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

If No, explain: ______

ARCADIS

4915 Prospectus Drive
Durham, NC 27713
(919) 544-4535
FAX (919) 544-5690

Report to: Dr. Dahman Touati

Bill to: Arcadis

Chain of Custody Record

27120005 2

PROJECT NUMBER
RN990272.0014 00001

PO#

PROJECT NAME
Burn hut #1

COLLECTED BY *(SIGNATURE)*
D. Janek

LABORATORY
EMSL Analytical Inc

107 WEST 4 TH Street Libby MT U.S 59923

REPORT FORMAT *(CIRCLE ALL REQUIRED)*
ELECTRONIC/VERBAL/FAX/HARDCOPY

FIELD SAMPLE ID	RUSH FACTOR	SAMPLE MATRIX	DATE/ TIME	No. of Containers								REMARKS	LAB ID NO. (for lab use only)
Blank		Wipe	2/23/12	1									[redacted]
Floor		Wipe	2/23/12	1									[redacted]
Left wall		Wipe	2/23/12	1									[redacted]
Right wall		Wipe	2/23/12	1									[redacted]
Door		Wipe	2/23/12	1									[redacted]
Window		Wipe	2/23/12	1									[redacted]
Top		Wipe	2/23/12	1									[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]

REMARKS Inside Burn Hut Wipes (1 square Ft. wipe area) Each

RELINQUISHED BY:	DATE	TIME

RECEIVED BY:	DATE	TIME	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME
R.K. Mahoney	2/27/12	1410						

ARCADIS
4915 Prospectus Drive
Durham, NC 27713
(919) 544-4535
FAX (919) 544-5690

Report to: Dr. Dahman Touati

Bill to: Arcadis

Chain of Custody Record

27120005 2

PROJECT NUMBER
RN990272.0014 00001

PO#

PROJECT NAME
Burn hut #1

COLLECTED BY *(SIGNATURE)*
D. Janek

LABORATORY
EMSL Analytical Inc

107 WEST 4 TH Street Libby MT U.S 59923

REPORT FORMAT *(CIRCLE ALL REQUIRED)*
ELECTRONIC/VERBAL/FAX/HARDCOPY

FIELD SAMPLE ID	RUSH FACTOR	SAMPLE MATRIX	DATE/ TIME	No. of Containers								REMARKS	LAB ID NO. (for lab use only)
Blank		Wipe	2/23/12	1									[redacted]
Floor		Wipe	2/23/12	1									[redacted]
Left wall		Wipe	2/23/12	1									[redacted]
Right wall		Wipe	2/23/12	1									[redacted]
Door		Wipe	2/23/12	1									[redacted]
Window		Wipe	2/23/12	1									[redacted]
Top		Wipe	2/23/12	1									[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]

REMARKS Inside Burn Hut Wipes (1 square Ft. wipe area) Each

RELINQUISHED BY:	DATE	TIME

RECEIVED BY:	DATE	TIME	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME
R.K. Mahoney	2/27/12	1410						

EMSL27 INDIRECT PREPARATION RECORD

EMSL Analytical Inc., Libby, MT

Order ID: 271200052

Circle One: TEM Air [✓ TEM Dust] PCM wipes **EFA:** 360 mm² 0.1µ PC

Date: 3/8/2012

Prepared By: DB

Sample #	Loose Material	Ashed Samples Resuspension with Ashing			Non-Ashed Samples Resuspension without Ashing			Serial Dilution Filtration 2nd resuspension			3rd resuspension			Prepared for Analysis
		Filter Fraction	Resuspended volume	Vol. applied to filter	~~Filter~~ Wipe DB 3/8/2012 Fraction	Resuspended volume	Vol. applied to filter	Vol. of 1st resuspension used	Resuspend volume	Vol. applied to filter	Vol of 2nd resuspension used	Resuspend volume	Vol. applied to filter	
	Y/N	fraction	mL	mL	fraction	mL	mL	mL	mL	mL	mL	mL	mL	Y/N
Blank	Y				1	500	⑩⓪ 100	← analyzed						Y
Floor	Y				1	500	10	10	100	10				
										⑤	← analyzed			Y
LEFT wall	Y				1	500	10							
							㉕	← analyzed						Y
Right wall	Y				1	500	10							
							㉕	← analyzed						Y
Door	Y				1	500	10							
							㊿	← analyzed						Y
window	Y				1	500	10							
							㉕	← analyzed						Y
TOP	Y				1	500	10							
							㉕	← analyzed						Y
MB	–				1	250	250							Y
						DB 3/8/2012								

EMSL Analytical, Inc.
107 West 4th Street, Libby, MT 59923
Phone: (406) 293-9066 Fax: Email: mobileasbestoslab@emsl.com

Attn: **Robert Marriam**
Remedium Group, Inc.
Subsidiary of W.R. Grace
6401 Poplar Avenue, Suite 301
Memphis, TN 38119
Fax: (901) 820-2061 Phone: (901) 820-2023

Customer ID: REME44
Customer PO:
Received: 02/27/12 2:10 PM
EMSL Order: 271200052

INTERNAL CHAIN OF CUSTODY

2/27/2012 5:03:44 PM

Order ID: 271200052

Attn: Robert Marriam
Remedium Group, Inc.
Subsidiary of W.R. Grace
6401 Poplar Avenue, Suite 301
Memphis, TN 38119
Fax: (901) 820-2061 Phone: (901) 820-2023
Project: **RN990272.0014 00001**
Low Temperature Burn Wipes

Customer ID: REME44
Customer PO:
Received: 02/27/12 2:10 PM
EMSL Order: 271200052
EMSL Proj ID: Burn House
Cust COC ID

Test: TEM 6480 **Matrix** Wipe **TAT:** 2 Week **Qty:** 7

Acct Sts: N30 **Slsprsn:** rdemalo **Logged:** rmahoney **Date:** 2/27/2012

Inter- Lab Sample Transfer

Samples Relinquished: Date
Samples Received: Date
Package Mailed to Westmont: Date
Method of Delivery:
Includes: (Circle)
Benchsheets Sample Slides Sample filters
Micrographs GridBox Other

Final Package Received: Date:

Sample Condition: ☐ Acceptable ☐ Unacceptable

Comments

Initial Prep (Initials/Lab): DB **Date:** 3/8/2012
Filter Prep (Initials/Lab): DB **Date:** 3/8/2012
Grid Prep (Initials/Lab): DB **Date:** 3/14/2012

For Special Projects Use Only

QC Selection: Date:
Date Package Review: Date:
Date Package Mailed: Date:

Special Instructions

Order ID	Lab Sample #	Cust. Sample #	Location	Due Date
271200052	271200052-0001	Blank		3/12/2012 2:10:00 PM
271200052	271200052-0002	Floor Ⓐ		3/12/2012 2:10:00 PM
271200052	271200052-0003	Left wall		3/12/2012 2:10:00 PM

LIBBY SITE
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	385
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	BLANK ~~Field~~ 3/22/12
Primary filter pore size (um)	0.1 ~~0.2~~ 3/22/12

EPA Sample Number:	Blank
Sample Type (A=Air, D=Dust, DF = Dustfall):	WIPE
Air volume (L), dust area (cm2), or dustfall container area (cm2)	
Date received by lab	2/27/2012
Lab Job Number:	271200052
Lab Sample Number:	271200052-0001
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	3/5/2012
EPA COC Number:	RN990272.0014 00001
Secondary filter pore size (um)	

Analyzed by	R. Pescador
Analysis date	3/22/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	~~no~~ 3/22/12
Estimated particulate loading on filter (%)	<1
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-36
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right----->

Recording Rules:

Minimum Aspect Ratio (circle one):

none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um):	0.5
Minimum Width (um):	none

Stopping Rules:

Target Sensitivity:	
Max # of GOs:	10
Target # of Structures:	25

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
A1	H2	nd														
	H4	nd														
	H6	nd														
	H8	nd														
	H10	nd														
A3	H2	nd														
	H4	nd														
	H6	nd														
	H8	nd														
	H10	nd														

LA = Libby-type amphibole

OA = Other (non-Libby type) amphibole

C = Chrysotile

NAM = Non-asbestos material

F-factor Calculation:

Indirect Prep Inputs

1	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
500	First resuspension volume or rinsate volume (mL)
100	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

Grid opening traverse direction (circle one):
H Horizontal
[✓ V Vertical]

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

If No, explain:

Page 1 of 4

LIBBY SITE
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	385
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.1 ~~0.2~~ 3/22/12

EPA Sample Number:	Floor
Sample Type (A=Air, D=Dust, DF = Dustfall):	WIPE
Air volume (L), dust area (cm2), or dustfall container area (cm2)	
Date received by lab	2/27/2012
Lab Job Number:	271200052
Lab Sample Number:	271200052-0002
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	3/5/2012
EPA COC Number:	RN990272.0014 00001
Secondary filter pore size (um)	

Analyzed by	R. Pescador
Analysis date	3/22/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	~~2~~ 3/22/12
Estimated particulate loading on filter (%)	2
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-36
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right----->

Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

Minimum Width (um): none

Stopping Rules:

Target Sensitivity:

Max # of GOs: 10

Target # of Structures: 25

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
B2	D0	F	1	1	1.40	0.20	ADX	1				 NaK/ WRA	1	Z1268 Z1269	1	
		F	2	2	5.15	0.40	ADX	1				 NaK/ WRA	1	Z1270 Z1271	1	
		F	3	3	0.60	0.15	ADX	1				 NaK/ WRA	1			
		F	4	4	1.40	0.15	ADX	1				 NaK/ WRA	1			
		F	5	5	4.20	0.70	ADX	1				 NaK/ WRA	1			
		F	6	6	1.35	0.25	ADX	1				 NaK/ WRA	1		1	
		F	7	7	1.25	0.20	ADX	1				 NaK/ WRA	1			
		F	8	8	1.0	0.20	ADX	1				 NaK/ WRA	1			
		F	9	9	1.0	0.20	ADX	1				 NaK/ WRA	1			
		F	10	10	1.50	0.15	ADX	1				 NaK/ WRA	1			

LA = Libby-type amphibole OA = Other (non-Libby type) amphibole C = Chrysotile NAM = Non-asbestos material

F-factor Calculation:

Indirect Prep Inputs

1.0	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
500	First resuspension volume or rinsate volume (mL)
10	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

100	Second resuspension volume (mL)
5	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

Grid opening traverse direction (circle one): H Horizontal [✓ V Vertical]

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

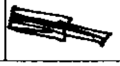
If No, explain

Page 2 of 4

LIBBY SITE

TEM Asbestos Structure Count

LAB NAME	EMSL27	EPA SAMPLE NO.	Floor	QA TYPE		LAB JOB NUMBER	271200052
LAB SAMPLE NO.	271200052-0002	SAMPLE TYPE	WIPE		Not QA	GRID STORAGE LOC.	2712-REM-36

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
B2	D6	F	11	11	6.25	0.25	ADX	1				 Naly WRTA	1			
		F	12	12	3.25	0.25	ADX	1				 Naly WRTA	1		1	
		F	13	13	3.65	0.35	ADX	1				 Naly WRTA	1		1	
		F	14	14	1.15	0.25	ADX	1				 Naly WRTA	1			
		F	15	15	1.30	0.30	ADX	1				 Naly WRTA	1			
		MD10	16													
		MF		16	1.50	0.50	ADX	1				 Naly WRTA	1			
		B	17	17	2.25	0.50	ADX	1				 Naly WRTA	1			
		F	18	18	1.30	0.25	ADX	1				 Naly WRTA	1			
		F	19	19	2.0	0.35	ADX	1				 Naly WRTA	1			
		F	20	20	5.25	0.50	ADX	1				 Naly WRTA	1			
		F	21	21	3.10	0.40	ADX	1				 Naly WRTA	1			
		F	22	22	0.75	0.10	ADX	1				 Naly WRTA	1			
B4	E8	F	23	23	11.50	0.50	ADX	1				 Naly WRTA	1			
		F	24	24	3.0	0.60	ADX	1				 Naly WRTA	1			

Page 3 of 4

LIBBY SITE

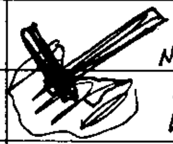
TEM Asbestos Structure Count

LAB NAME EMSL27
LAB SAMPLE NO. 271200052-0002

EPA SAMPLE NO. Floor
SAMPLE TYPE WIPE

QA TYPE Not QA

LAB JOB NUMBER 271200052
GRID STORAGE LOC. 2712-REM-36

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
B4	E8	F	25	25	0.90	0.20	AOX	1				 Nak/ WRTX	1			
		F	26	26	3.40	0.25	AOX	1				 Nak/ WRTX	1			
		F	27	27	1.85	0.40	AOX	1				 Nak/ WRTX	1			
		F	28	28	0.80	0.20	AOX	1				 Nak/ WRTX	1			
		F	29	29	4.75	0.75	AOX	1				 Nak/ WRTX	1			
		MD20	30													
		MF		31	3.10	0.30	AOX	1				 Nak/WRTX	1			
		MF		32	2.25	0.20	AOX	1				Nak/ WRTX	1			
		F	31	33	3.0	0.15	AOX	1				 Nak/ WRTX	1			
		F	32	34	9.0	0.90	AOX	1				 Nak/ WRTX	1			
		F	33	35	2.65	0.50	AOX	1				 Nak/ WRTX	1			
		F	34	36	10.50	1.20	AOX	1				 Nak/ WRTX	1			
		F	35	37	1.70	0.20	AOX	1				 Nak/ WRTX	1			
		F	36	38	1.50	0.15	AOX	1				 Nak/ WRTX	1			
		F	37	39	1.20	0.20	AOX	1				 Nak/ WRTX	1			

Page 4 of 4

LIBBY SITE

TEM Asbestos Structure Count

LAB NAME	EMSL27	EPA SAMPLE NO.	Floor	QA TYPE		LAB JOB NUMBER	271200052
LAB SAMPLE NO.	271200052-0002	SAMPLE TYPE	WIPE		Not QA	GRID STORAGE LOC.	2712-REM-36

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
34	E8	F	38	40	1.15	0.25	ADX	1				 Nak/ WRT	1			
		F	39	41	3.0	0.25	ADX	1				 Nak/ WRT	1			
		F	40	42	7.80	0.50	ADX	1				 Nak/ WRT	1			
		F	41	43	2.55	0.25	ADX	1				 Nak/ WRT	1			
		F	42	44	1.75	0.20	ADX	1				 Nak/ WRT	1			

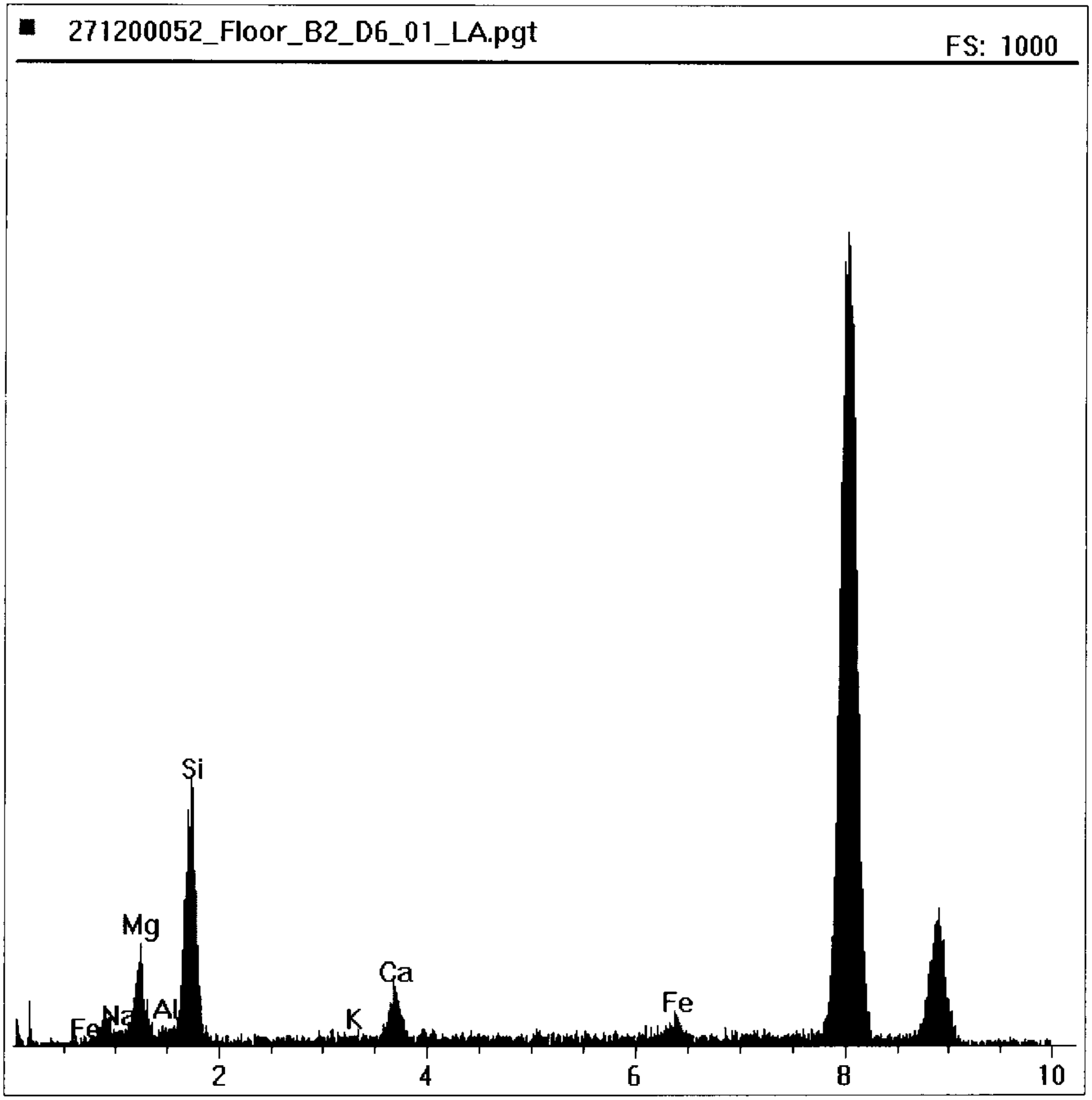
3/22/12

Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...EMSL27-2\EMSL27-2 2012\271200052_Floor_B2_D6_01_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	179.37	Count Rate:	691	Dead Time:	36.26 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

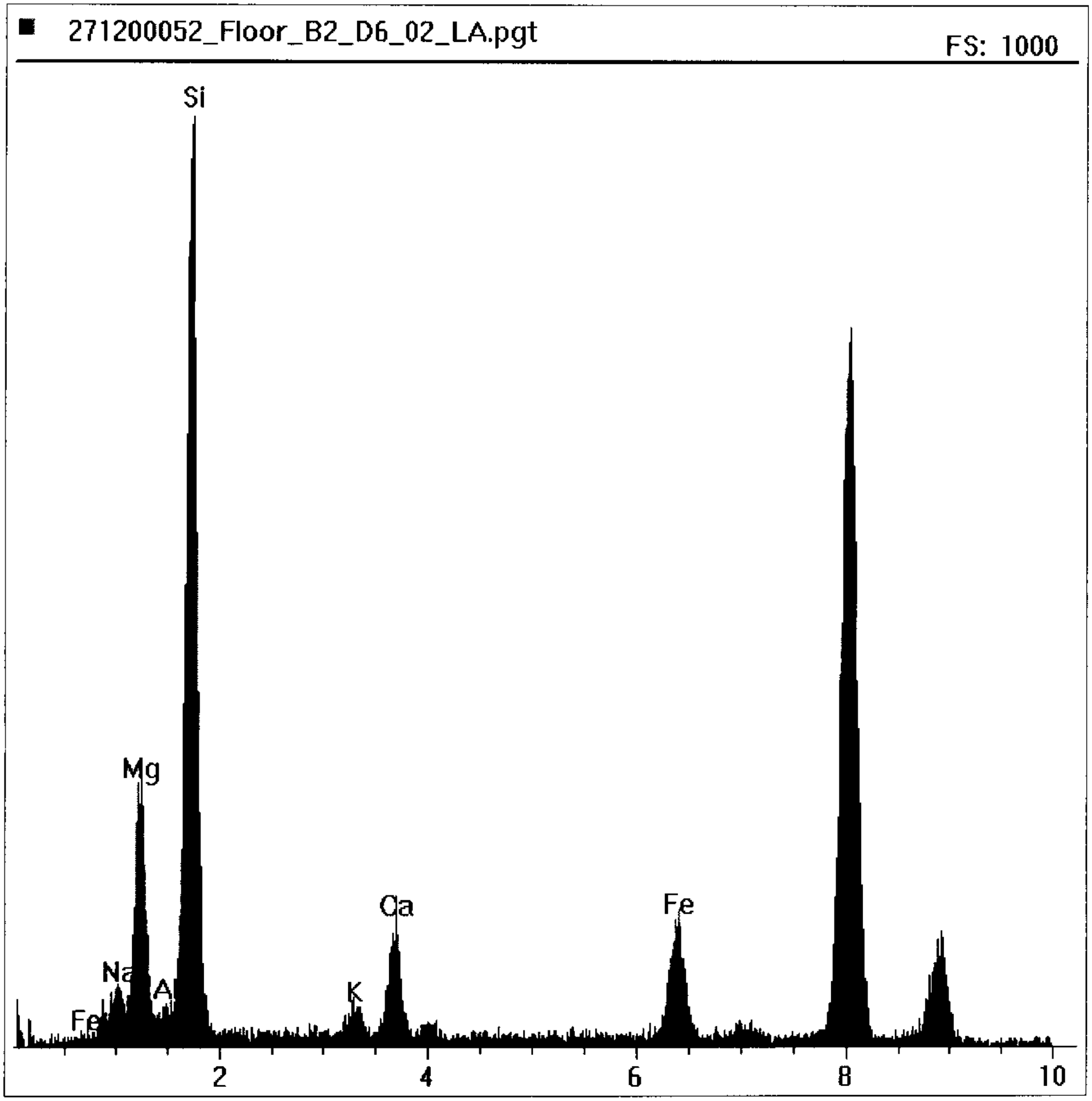


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...EMSL27-2\EMSL27-2 2012\271200052_Floor_B2_D6_02_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	153.42	Count Rate:	1231	Dead Time:	38.78 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

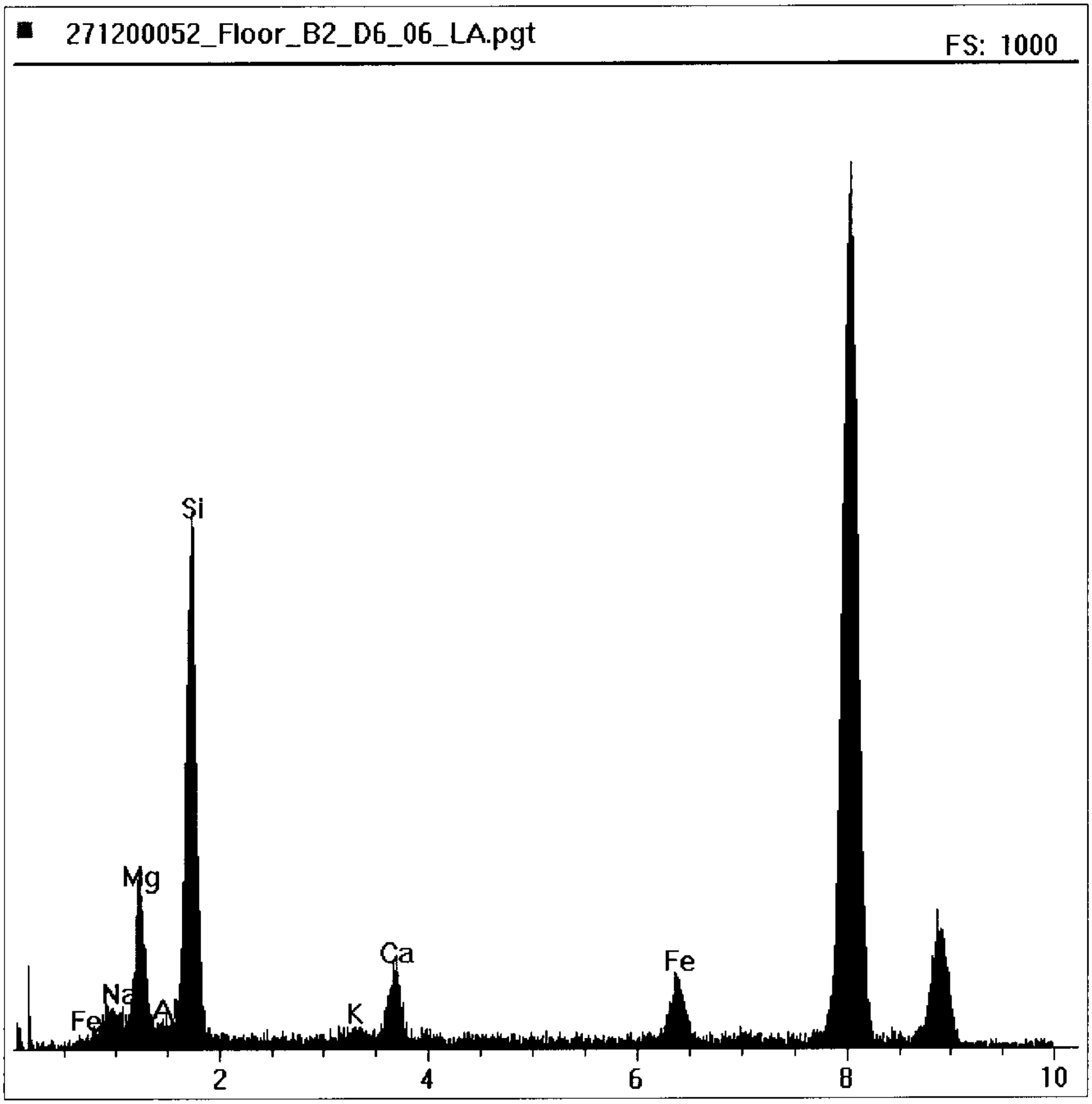


Energy Dispersive X-Ray Analysis Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...EMSL27-2\EMSL27-2 2012\271200052_Floor_B2_D6_06_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time: 221.08
Count Rate: 723
Dead Time: 35.61 %
Beam Voltage: 20.00
Beam Current: 2.00
Takeoff Angle: 57.98

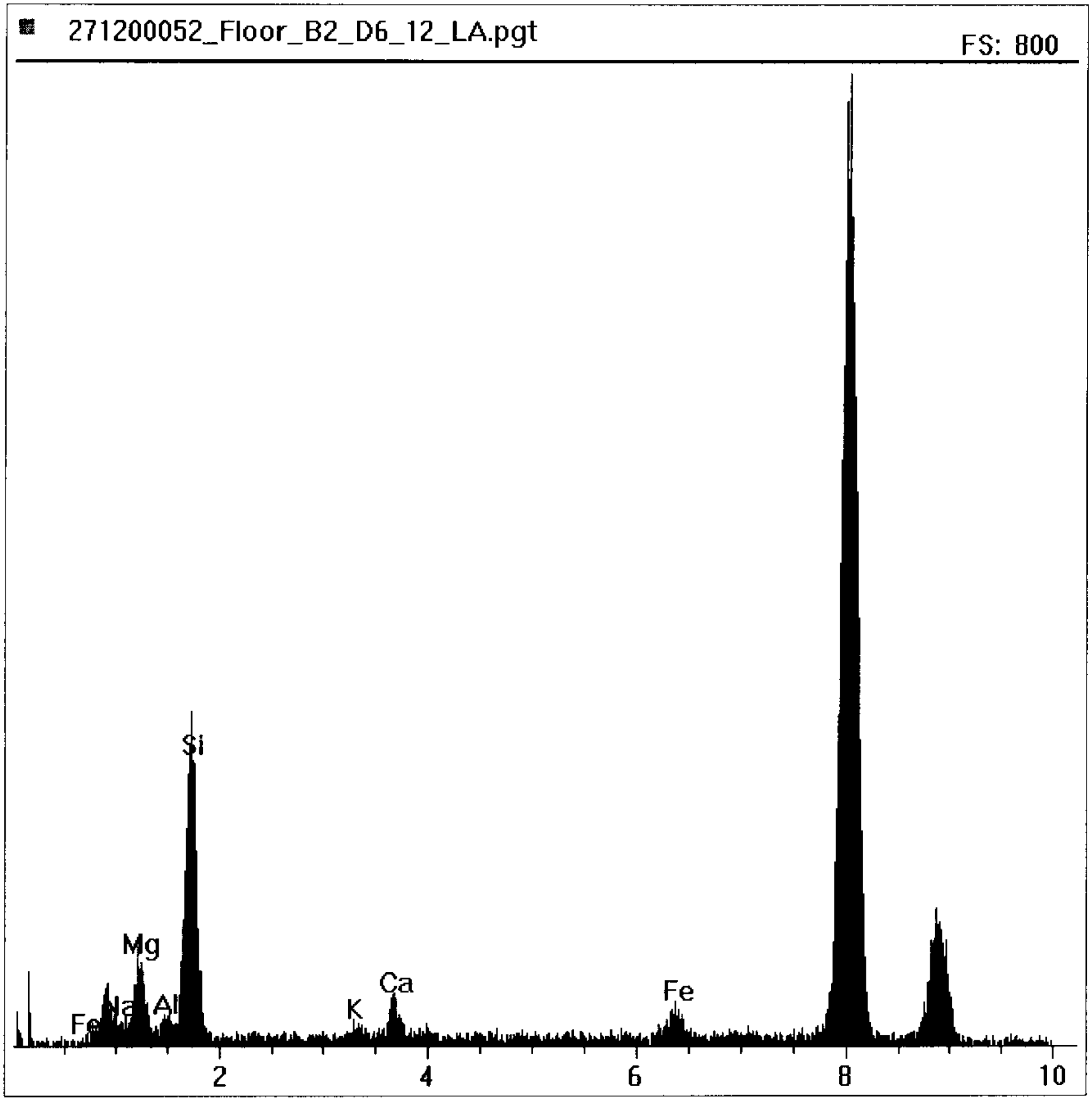


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...EMSL27-2\EMSL27-2 2012\271200052_Floor_B2_D6_12_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	198.54	Count Rate:	572	Dead Time:	34.67 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

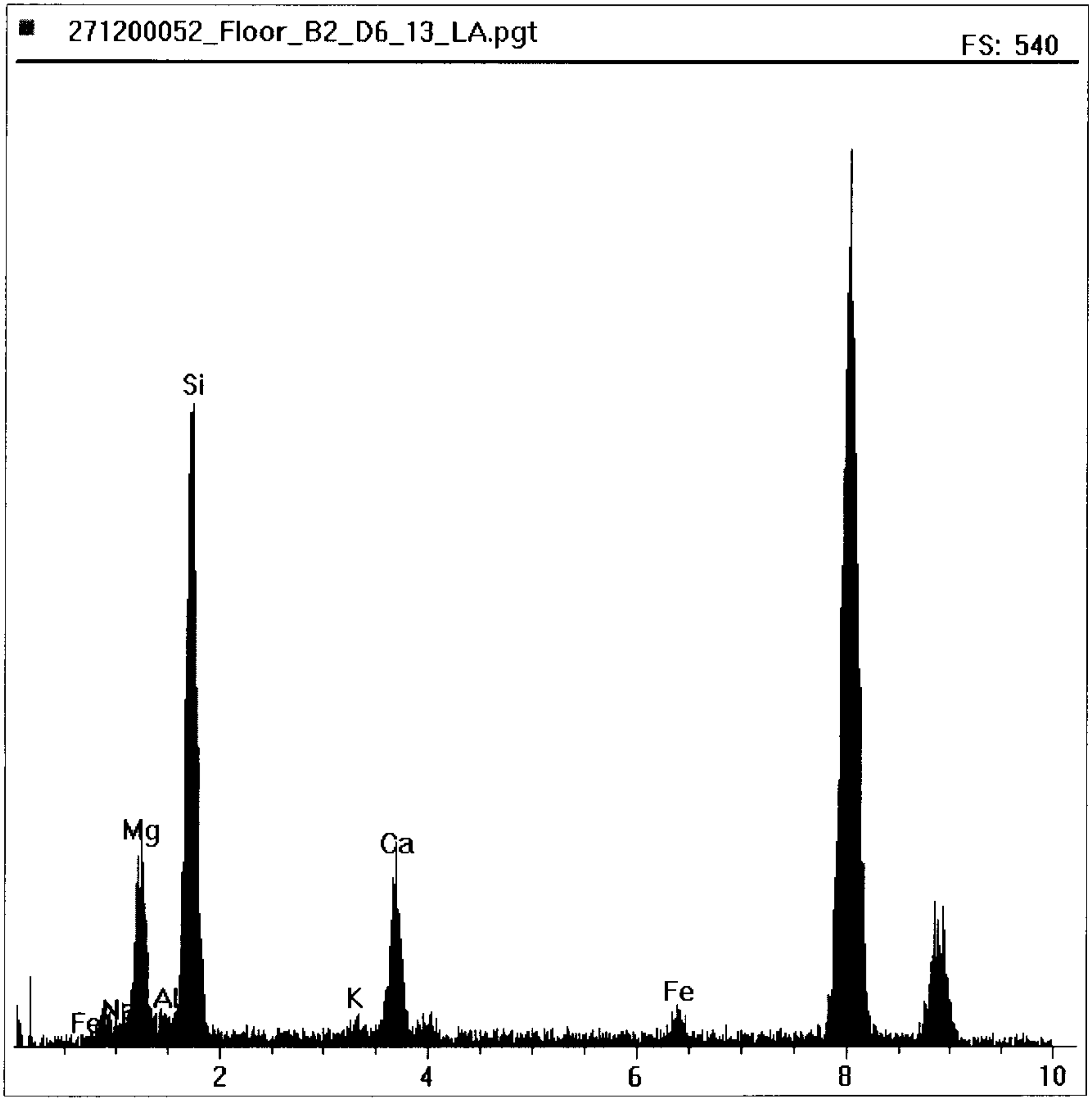


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...EMSL27-2\EMSL27-2 2012\271200052_Floor_B2_D6_13_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	119.97	Count Rate:	763	Dead Time:	36.37 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98



LIBBY SITE
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	385
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.1 0.2 R 3/22/12

EPA Sample Number:	Left Wall
Sample Type (A=Air, D=Dust, DF = Dustfall):	WIPE
Air volume (L), dust area (cm2), or dustfall container area (cm2)	
Date received by lab	2/27/2012
Lab Job Number:	271200052
Lab Sample Number:	271200052-0003
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	3/5/2012
EPA COC Number:	RN990272.0014 00001
Secondary filter pore size (um)	

Analyzed by	R. Pescador
Analysis date	3/22/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	
Estimated particulate loading on filter (%)	2
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-36
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right----->

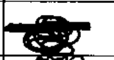
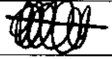
Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um):	0.5
Minimum Width (um):	none

Stopping Rules:

Target Sensitivity:	
Max # of GOs:	10
Target # of Structures:	25

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
C1	E8	F	1	1	0.75	0.10	ADX	1				 Naly WRTA	1			
		MD10	2													
		MF		2	1.50	0.25	ADX	1				 Naly WRTA	1			
		F	3	3	1.75	0.20	ADX	1				 Naly WRTA	1	27272 27273	1	
	E10	F	4	4	0.80	0.20	ADX	1				 Naly WRTA	1		1	
		F	5	5	3.15	0.45	ADX	1				 Naly WRTA	1		1	
		F	6	6	3.65	0.15	ADX	1				 Naly WRTA	1			
		F	7	7	1.25	0.20	ADX	1				 Naly WRTA	1			
		B	8	8	12.75	0.65	ADX	1				 Naly WRTA	1		1	
	G4	F	9	9	2.80	0.60	ADX	1				 Naly WRTA	1			

LA = Libby-type amphibole

OA = Other (non-Libby type) amphibole

C = Chrysotile

NAM = Non-asbestos material

F-factor Calculation:

Indirect Prep Inputs

1.0	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
500	First resuspension volume or rinsate volume (mL)
25	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

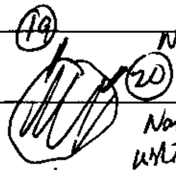
Grid opening traverse direction (circle one): Horizontal [✓ Vertical]

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

If No, explain

LIBBY SITE
TEM Asbestos Structure Count

LAB NAME: EMSL27
LAB SAMPLE NO.: 271200052-0003
EPA SAMPLE NO.: Left Wall
SAMPLE TYPE: WIPE
QA TYPE: Not QA
LAB JOB NUMBER: 271200052
GRID STORAGE LOC.: 2712-REM-36

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
C1	G4	F	10	10	18.80	0.40	ADX	1				 Naly WXTA	1		1	
		F	11	11	1.15	0.15	ADX	1				 Naly WXTA	1			
C3	C8	F	12	12	2.0	0.35	ADX	1				 Naly WXTA	1			
		F	13	13	11.70	0.25	ADX	1				 Naly WXTA	1			
		F	14	14	3.90	0.30	ADX	1				 Naly WXTA	1			
		F	15	15	1.15	0.15	ADX	1				 Naly WXTA	1			
		~~F~~ F 3/22/12	16	16	1.0	0.20	ADX	1				 Naly WXTA	1			
		F	17	17	5.75	0.65	ADX	1				 Naly WXTA	1			
	C10	F	18	18	1.0	0.20	ADX	1				 Naly WXTA	1			
		MD20	19													
		MF		19	1.25	0.20	ADX	1				 Naly WXTA	1			
		MF		20	1.25	0.20	ADX	1				Naly WXTA	1			
	F9	F	20	21	5.75	0.30	ADX	1				 Naly WXTA	1			
		F	21	22	3.20	0.20	ADX	1				 Naly WXTA	1			
		B	22	23	1.80	0.70	ADX	1				 Naly WXTA	1			

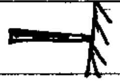
LIBBY SITE

TEM Asbestos Structure Count

LAB NAME	EMSL27	EPA SAMPLE NO.	Left Wall	QA TYPE	LAB JOB NUMBER
LAB SAMPLE NO.	271200052-0003	SAMPLE TYPE	WIPE	Not QA	GRID STORAGE LOC.

LAB JOB NUMBER: 271200052

GRID STORAGE LOC.: 2712-REM-36

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
C3	F9	F	23	24	4.80	0.30	ADX	1				 NaK w/LA	1			
		F	24	25	3.50	0.25	ADX	1				 NaK w/LA	1			

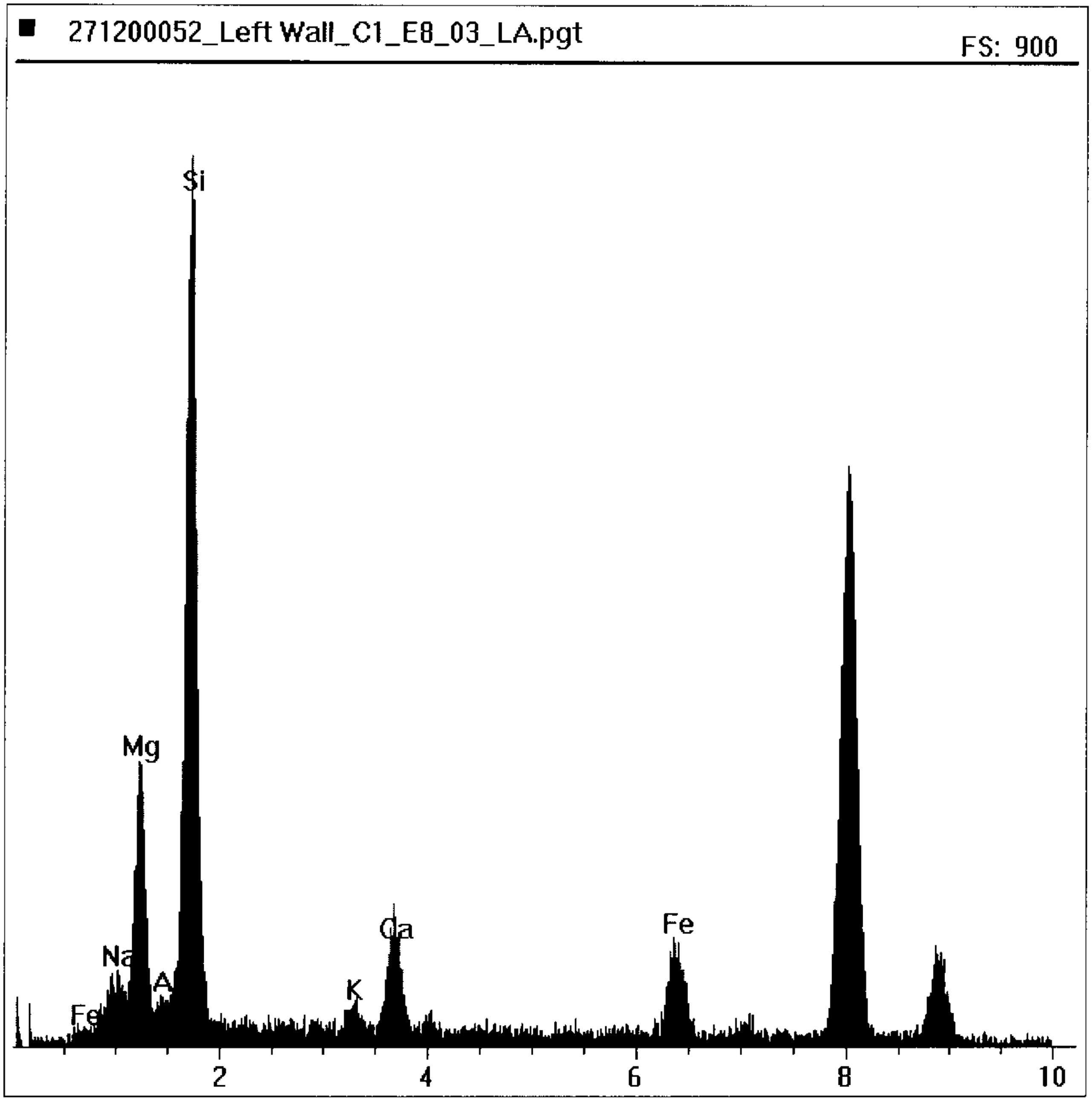
3/22/12

Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...27-2\EMSL27-2 2012\271200052_Left Wall_C1_E8_03_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	84.86	Count Rate:	2060	Dead Time:	46.23 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

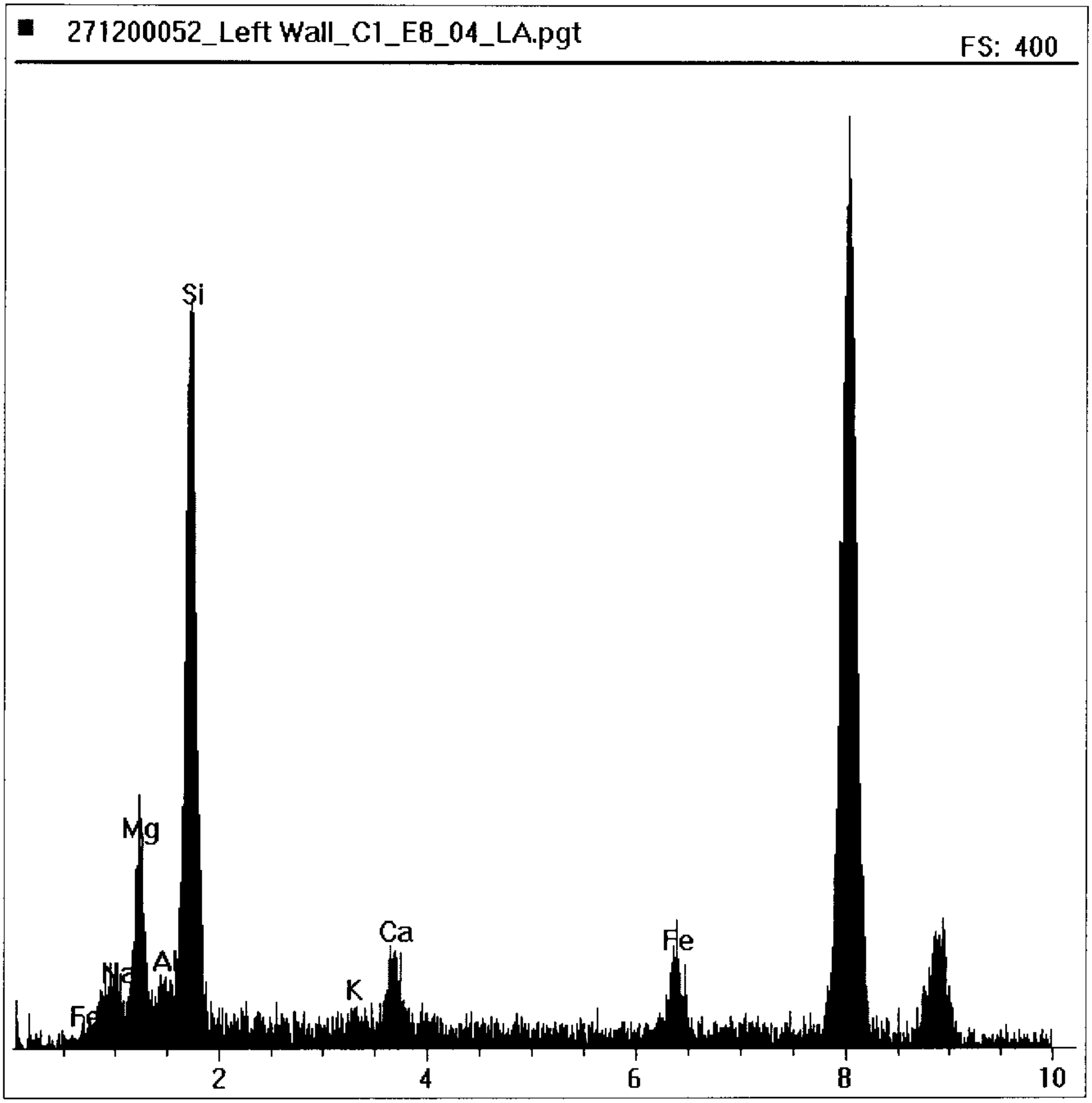


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...27-2\EMSL27-2 2012\271200052_Left Wall_C1_E8_04_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	41.02	Count Rate:	2141	Dead Time:	44.73 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

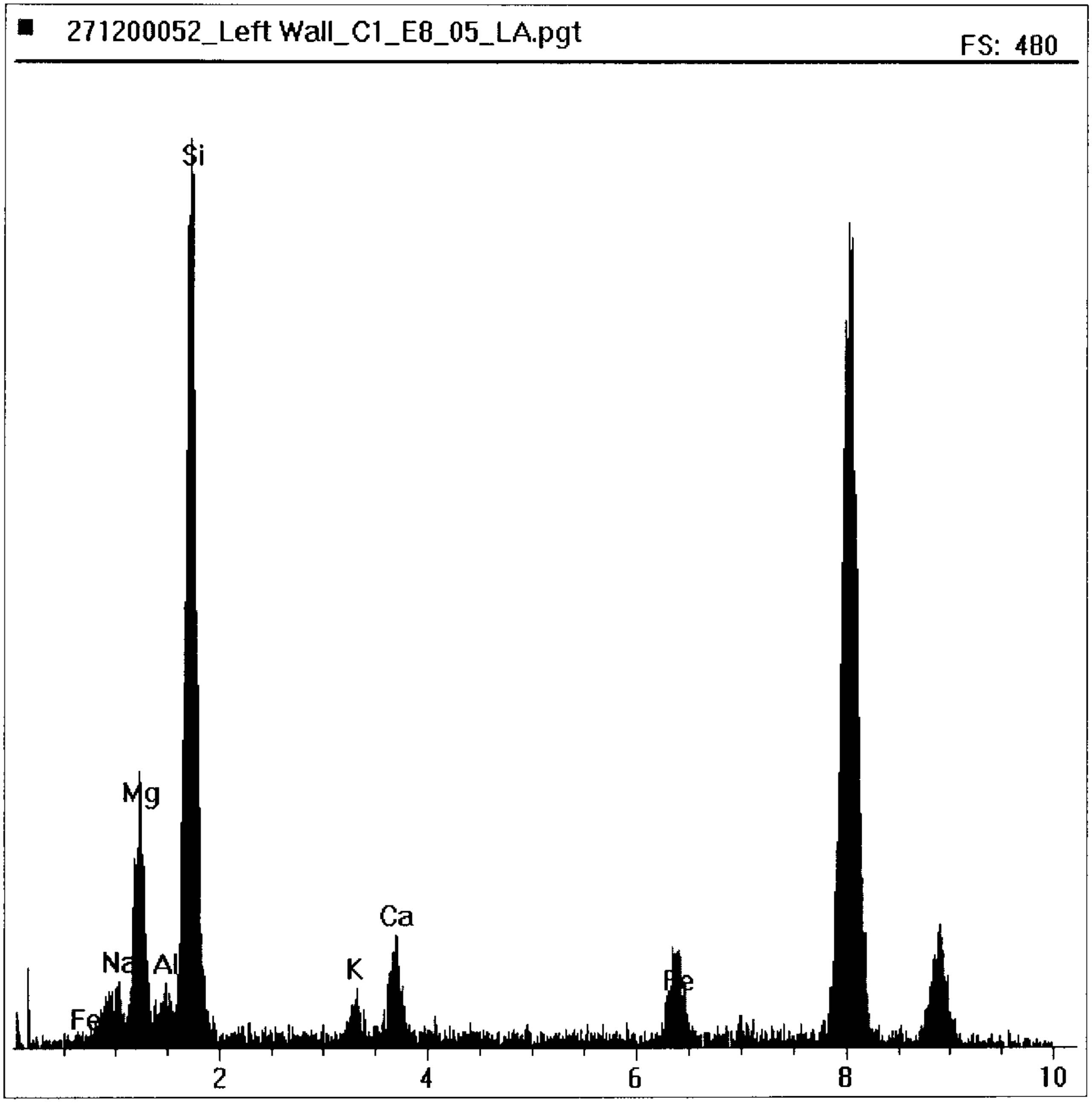


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...27-2\EMSL27-2 2012\271200052_Left Wall_C1_E8_05_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	106.72	Count Rate:	853	Dead Time:	36.12 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

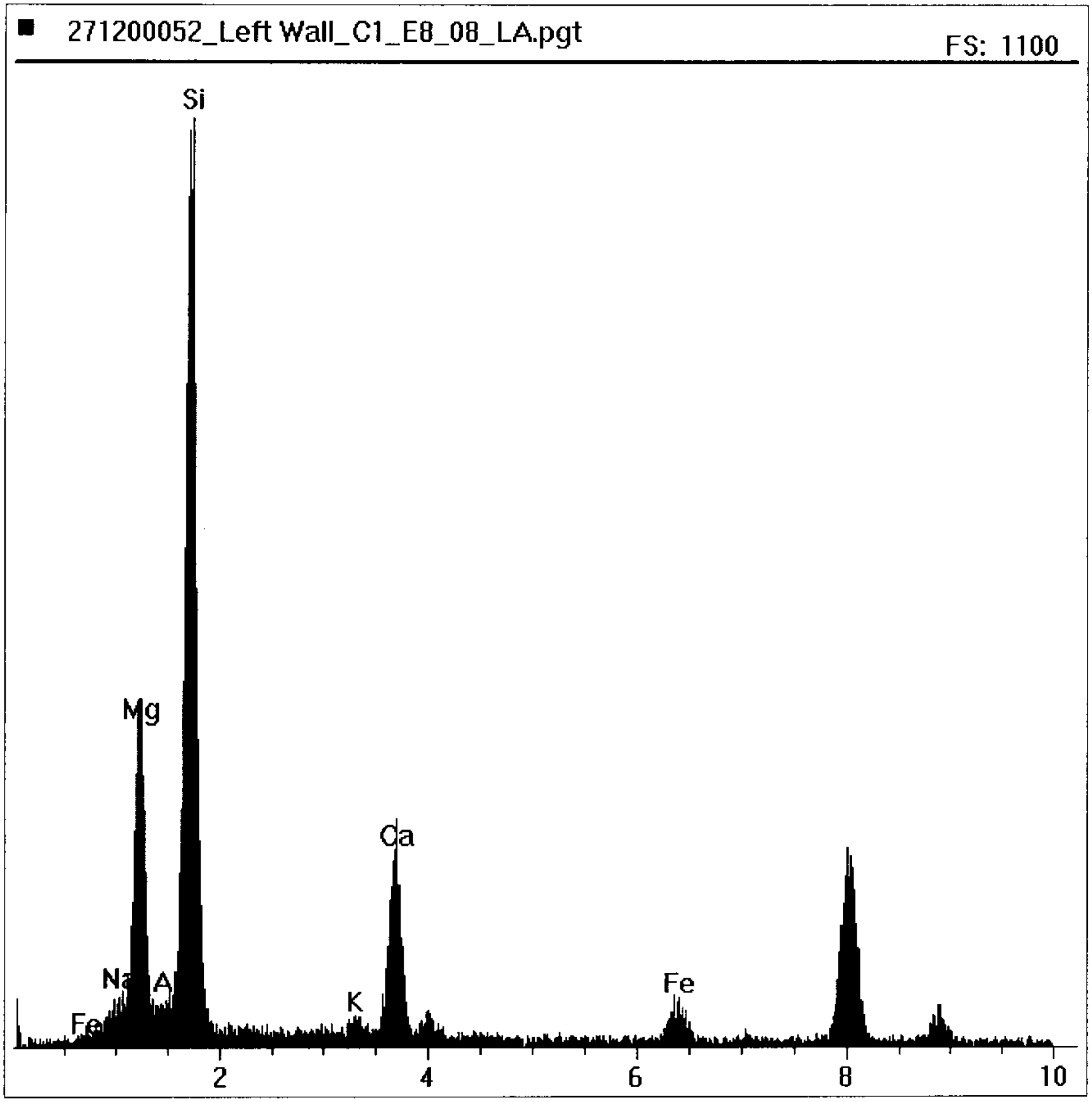


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...27-2\EMSL27-2 2012\271200052_Left Wall_C1_E8_08_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	12.81	Count Rate:	12172	Dead Time:	80.53 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

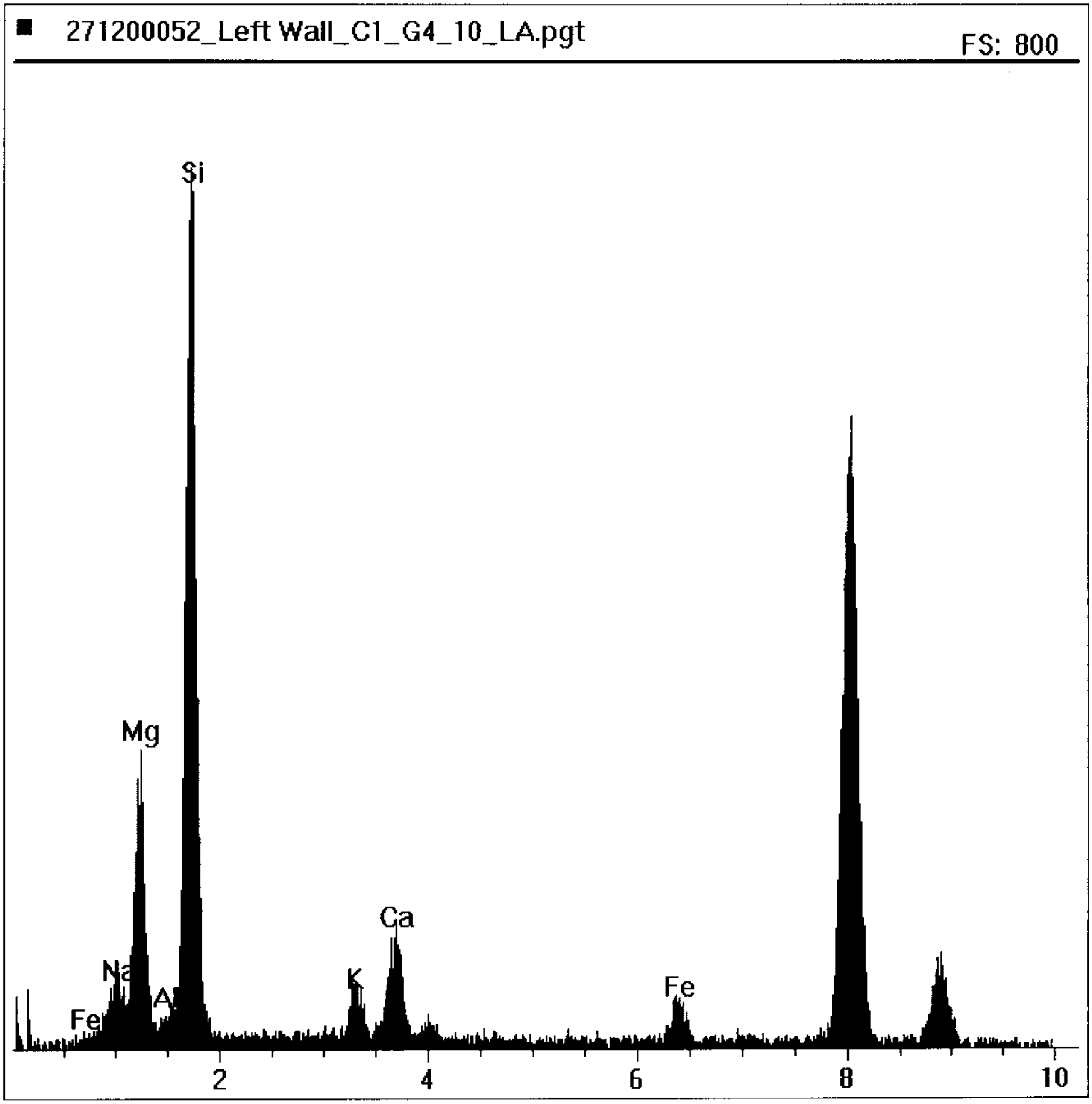


Energy Dispersive X-Ray Analysis Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...27-2\EMSL27-2 2012\271200052_Left Wall_C1_G4_10_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	154.64	Count Rate:	873	Dead Time:	36.49 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98



LIBBY SITE
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	385
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.1 ~~0.2~~ 3/12/12

EPA Sample Number:	Right Wall
Sample Type (A=Air, D=Dust, DF = Dustfall):	WIPE
Air volume (L), dust area (cm2), or dustfall container area (cm2)	
Date received by lab	2/27/2012
Lab Job Number:	271200052
Lab Sample Number:	271200052-0004
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	3/5/2012
EPA COC Number:	RN990272.0014 00001
Secondary filter pore size (um)	

Analyzed by	R. Pescador
Analysis date	3/22/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	
Estimated particulate loading on filter (%)	<2
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-36
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right---->

Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

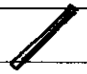
Minimum Width (um): none

Stopping Rules:

Target Sensitivity:

Max # of GOs: 10

Target # of Structures: 25

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
D2	D7	F	1	1	1.60	0.20	ADX	1				 Naly WRTS	1	27274 27275	1	
	D9	F	2	2	5.25	0.25	ADX	1				 Naly WRTS	1		1	
	F5	nd					/									
	F7	nd														
	F9	nd														
D4	D6	F	3	3	3.70	0.30	ADX	1				 Naly WRTA	1		1	
	D8	F	4	4	1.50	0.20	ADX	1				 Naly WRTS	1		1	
	D10	F	5	5	9.80	0.50	ADX	1				 Naly WRTA	1			
	F7	F	6	6	7.90	0.60	ADX	1					1			
	F9	nd														

LA = Libby-type amphibole

OA = Other (non-Libby type) amphibole

C = Chrysotile

NAM = Non-asbestos material

F-factor Calculation:

Indirect Prep Inputs

1.0	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
500	First resuspension volume or rinsate volume (mL)
25	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

Grid opening traverse direction (circle one):

H Horizontal

[✓ V] Vertical

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

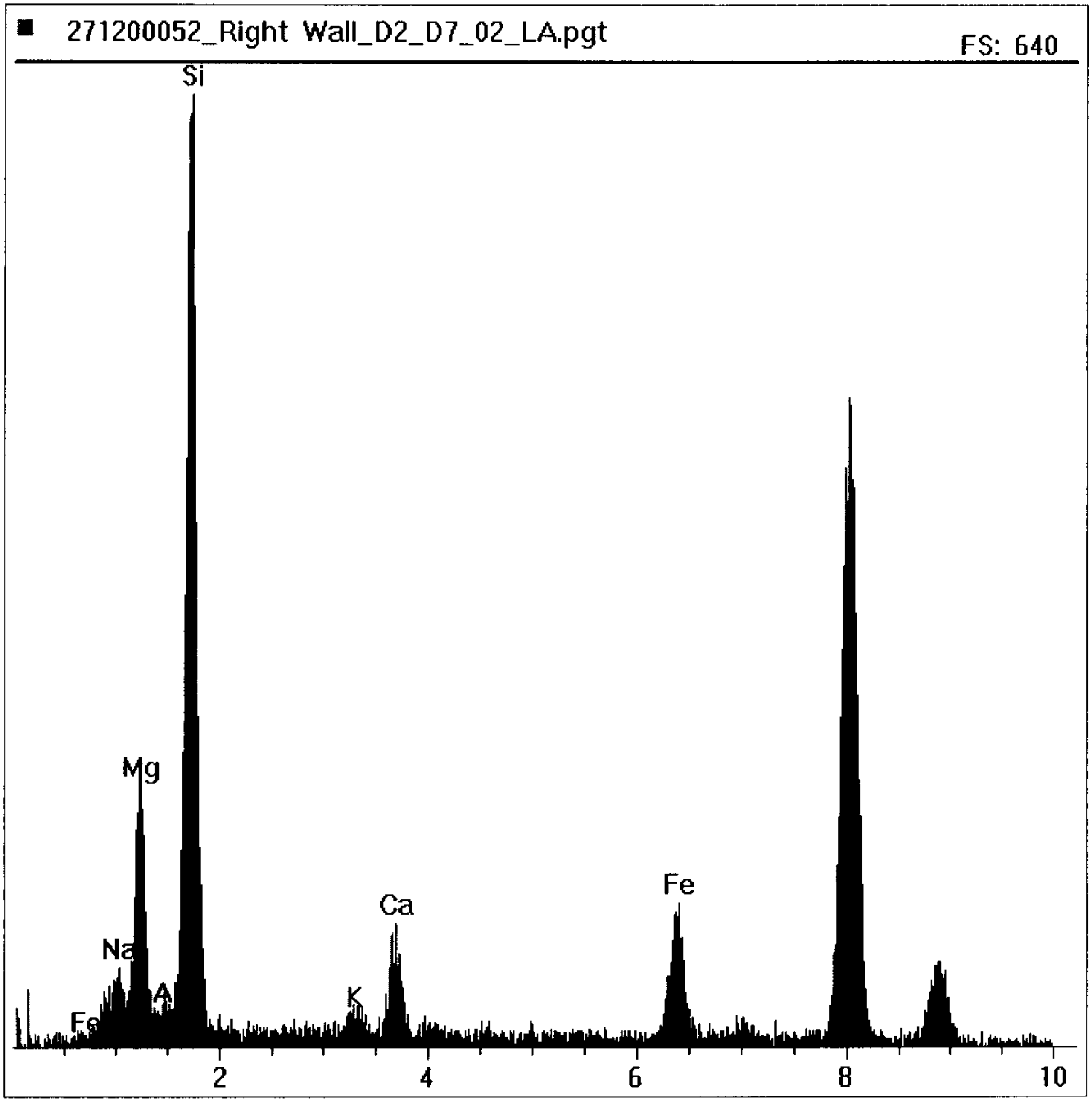
If No, explain:

Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...-2\EMSL27-2 2012\271200052_Right Wall_D2_D7_02_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	119.26	Count Rate:	991	Dead Time:	36.23 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

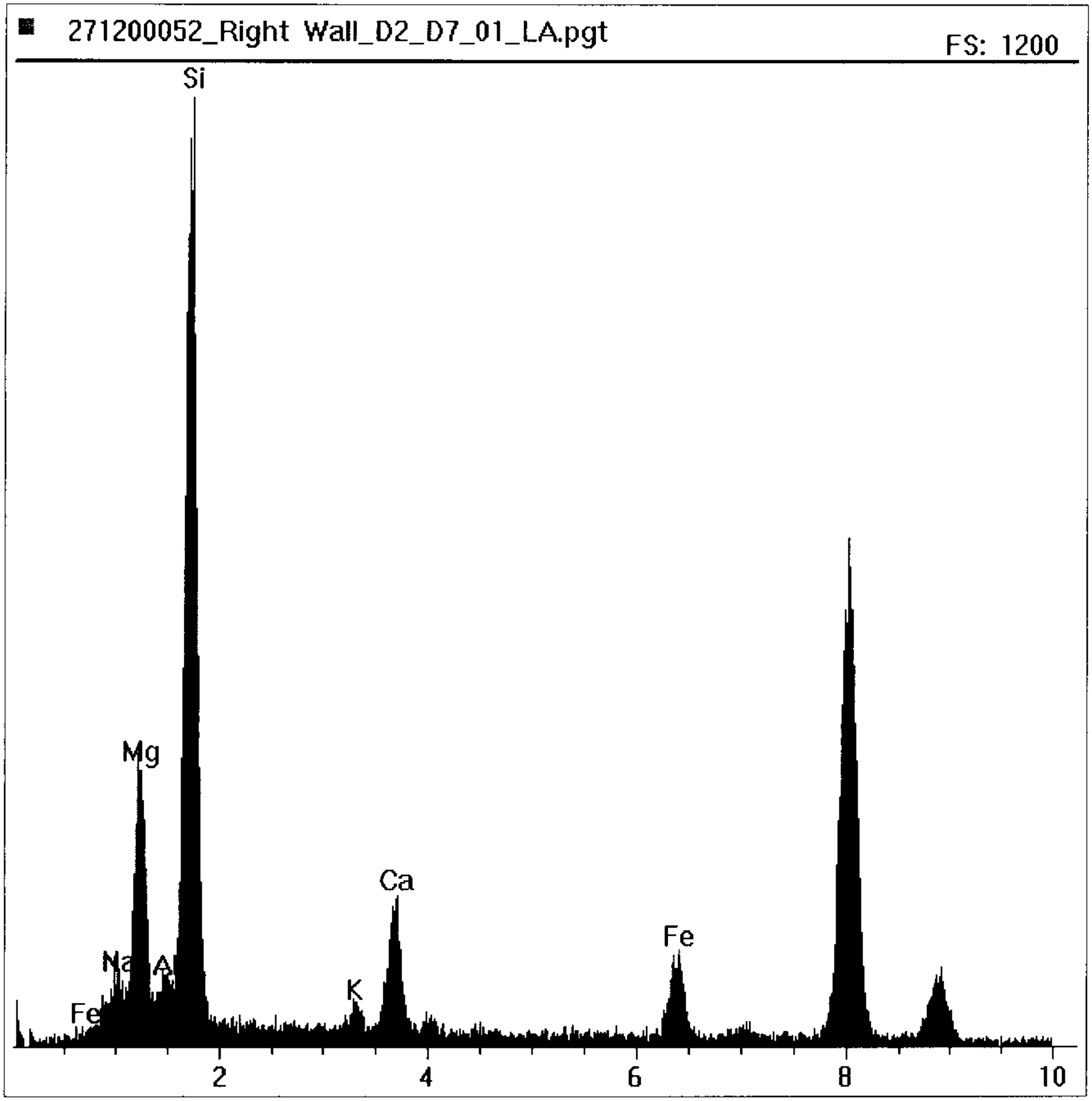


Energy Dispersive X-Ray Analysis Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...-2\EMSL27-2 2012\271200052_Right Wall_D2_D7_01_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	40.24	Count Rate:	5525	Dead Time:	60.41 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

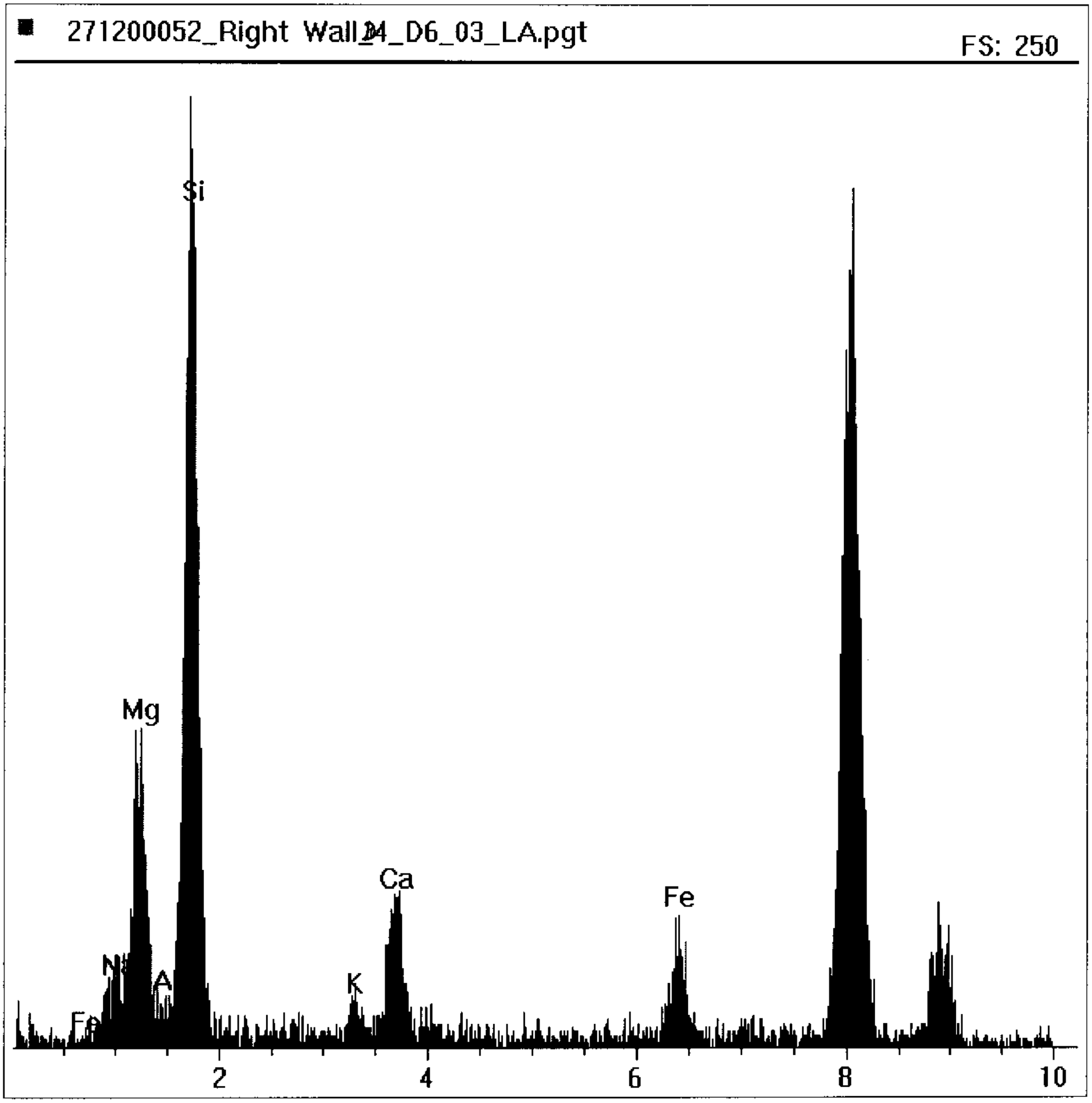


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...7-2\EMSL27-2 2012\271200052_Right Wall_4_D6_03_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	54.70	Count Rate:	1037	Dead Time:	41.09 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

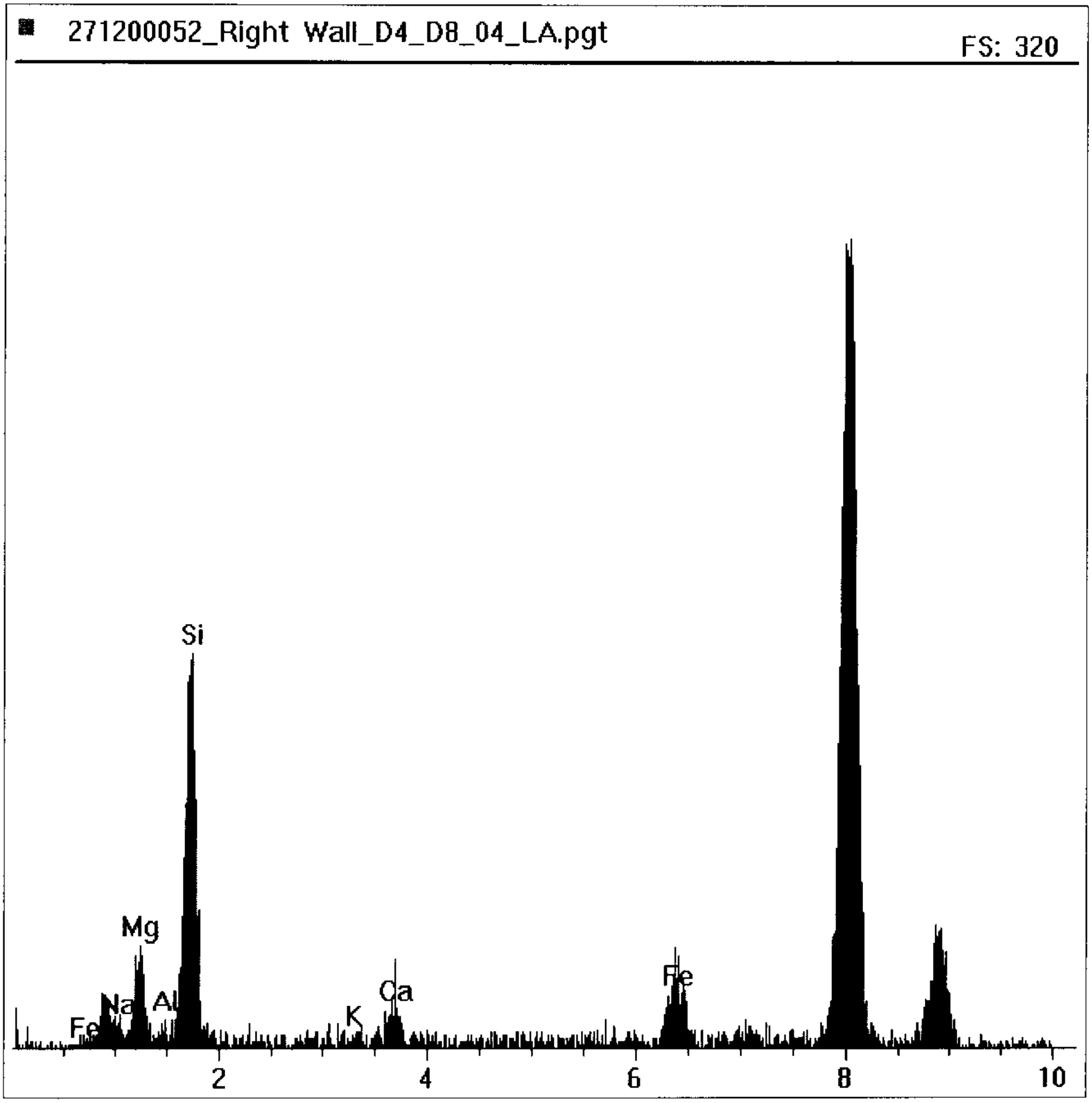


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...-2\EMSL27-2 2012\271200052_Right Wall_D4_D8_04_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	46.26	Count Rate:	952	Dead Time:	35.11 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

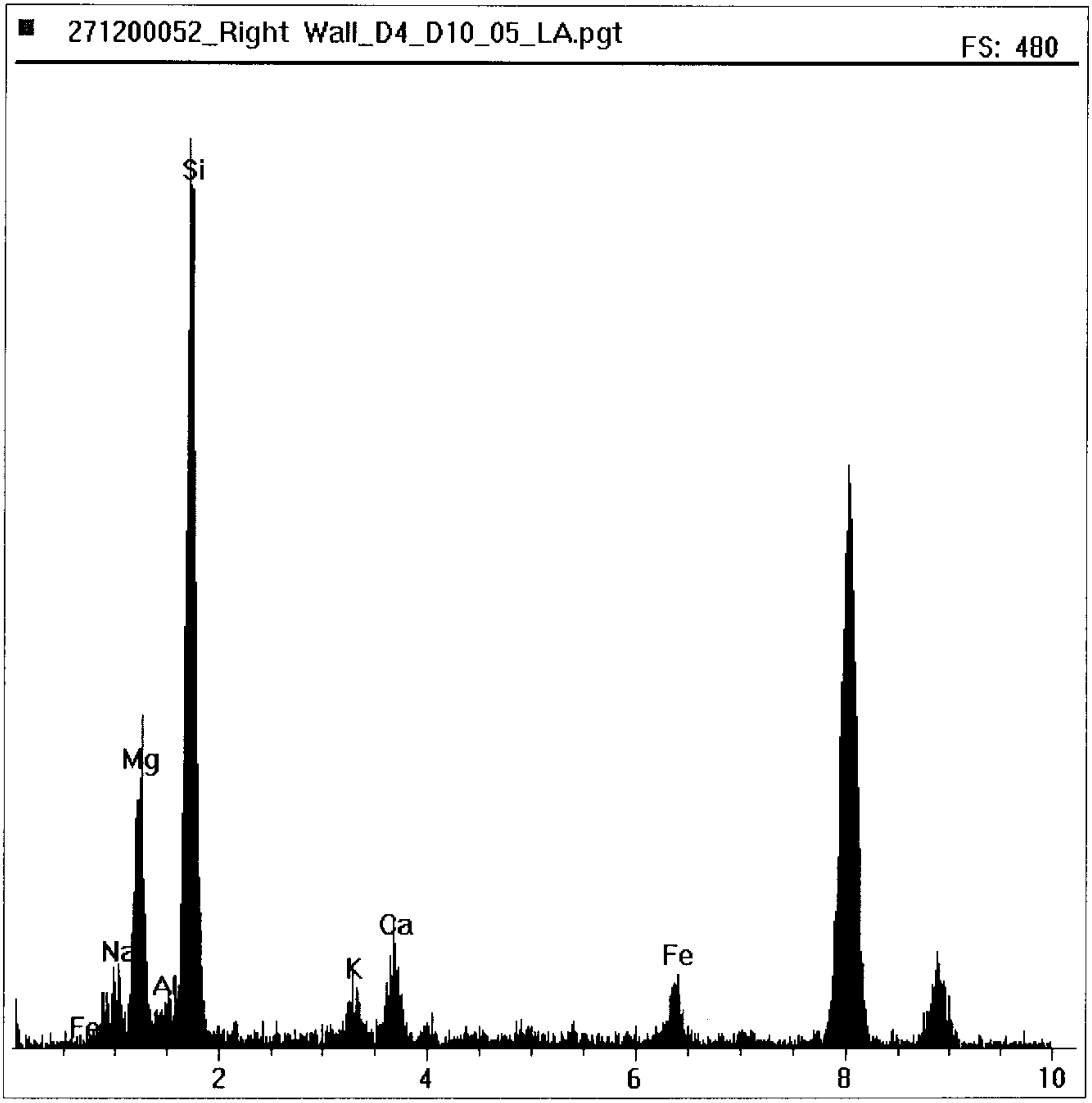


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...2\EMSL27-2 2012\271200052_Right Wall_D4_D10_05_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	31.99	Count Rate:	2378	Dead Time:	43.29 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98



LIBBY SITE
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	385
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	~~0.1~~ 0.2 3/23/12

EPA Sample Number:	Door
Sample Type (A=Air, D=Dust, DF = Dustfall):	WIPE
Air volume (L), dust area (cm2), or dustfall container area (cm2)	
Date received by lab	2/27/2012
Lab Job Number:	271200052
Lab Sample Number:	271200052-0005
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	3/5/2012
EPA COC Number:	RN990272.0014 00001
Secondary filter pore size (um)	

Analyzed by	E.Wyatt-Pescador
Analysis date	3/22/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	
Estimated particulate loading on filter (%)	5
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-36
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right---->

Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

Minimum Width (um): none

Stopping Rules:

Target Sensitivity:	
Max # of GOs:	10
Target # of Structures:	25

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
E1	C7	F	1	1	3.10	0.30	ADX	1				 NAK/WRTA	1	27276 27278	1	
	C9	NO														
	EC6	F	2	2	3.10	0.20	ADX	1				 NAK/WRTA	1		1	
		F	3	3	6.00	0.55	ADX	1				 NAK/WRTA	1		1	
		F	4	4	3.50	0.40	ADX	1				 NAK/WRTA	1			
	E8	NO														
	E10	NO														
E3	C8	F	5	5	3.00	0.15	ADX	1				 NAK/WRTA	1			
		MD10	6													
		MF		6	1.90	0.20	ADX	1				 NAK/WRTA	1			

LA = Libby-type amphibole OA = Other (non-Libby type) amphibole C = Chrysotile NAM = Non-asbestos material

F-factor Calculation:

Indirect Prep Inputs

1.0	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
500	First resuspension volume or rinsate volume (mL)
50	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

Grid opening traverse direction (circle one):
H Horizontal
[✓ V] Vertical

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

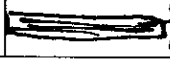
If No, explain

Page 2 of 3

LIBBY SITE

TEM Asbestos Structure Count

LAB NAME: EMSL27
LAB SAMPLE NO.: 271200052-0005
EPA SAMPLE NO.: Door
SAMPLE TYPE: WIPE
QA TYPE: Not QA
LAB JOB NUMBER: 271200052
GRID STORAGE LOC.: 2712-REM-36

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
E3	C8	F	7	7	2.00	0.25	ADX	1				 NAK WRTA	1		1	
		F	8	8	10.40	0.30	ADX	1				 NAK WRTA	1			
		F	9	9	5.30	0.80	ADX	1				 NAK WRTA	1			
		F	10	10	3.90	0.25	ADX	1				 NAK WRTA	1			
	C10	F	11	11	1.50	0.20	ADX	1				 NAK WRTA	1			
		F	12	12	2.10	0.20	ADX	1				 NAK WRTA	1			
		F	13	13	2.75	0.50	ADX	1				 NAK WRTA	1			
		F	14	14	2.80	0.50	ADX	1				 NAK WRTA	1			
		F	15	15	1.20	0.15	ADX	1				 NAK WRTA	1		1	
		F	16	16	10.70	0.40	ADX	1				 NAK WRTA	1			
		F	17	17	4.75	0.25	ADX	1				 NAK WRTA	1			
		F	18	18	2.80	0.20	ADX	1				 NAK WRTA	1			
	F5	F	19	19	7.90	0.70	ADX	1				 NAK WRTA	1			
		F	20	20	1.90	0.25	ADX	1				 NAK WRTA	1			
		F	21	21	24.75	0.75	ADX	1				 NAK WRTA	1			

LIBBY SITE
TEM Asbestos Structure Count

LAB NAME: EMSL27
LAB SAMPLE NO.: 271200052-0005
EPA SAMPLE NO.: Door
SAMPLE TYPE: WIPE
QA TYPE: Not QA
LAB JOB NUMBER: 271200052
GRID STORAGE LOC.: 2712-REM-36

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
E3	F7	F	22	22	2.70	0.70	AOX	1				 NaK LKRTA	1			
		F	23	23	1.70	0.50	AOX	1				 NaK LRTA	1			
		F	24	24	3.00	0.25	AOX	1				 NaK LRTA	1			
		F	25	25	1.75	0.20	AOX	1				 NaK LRTA	1			

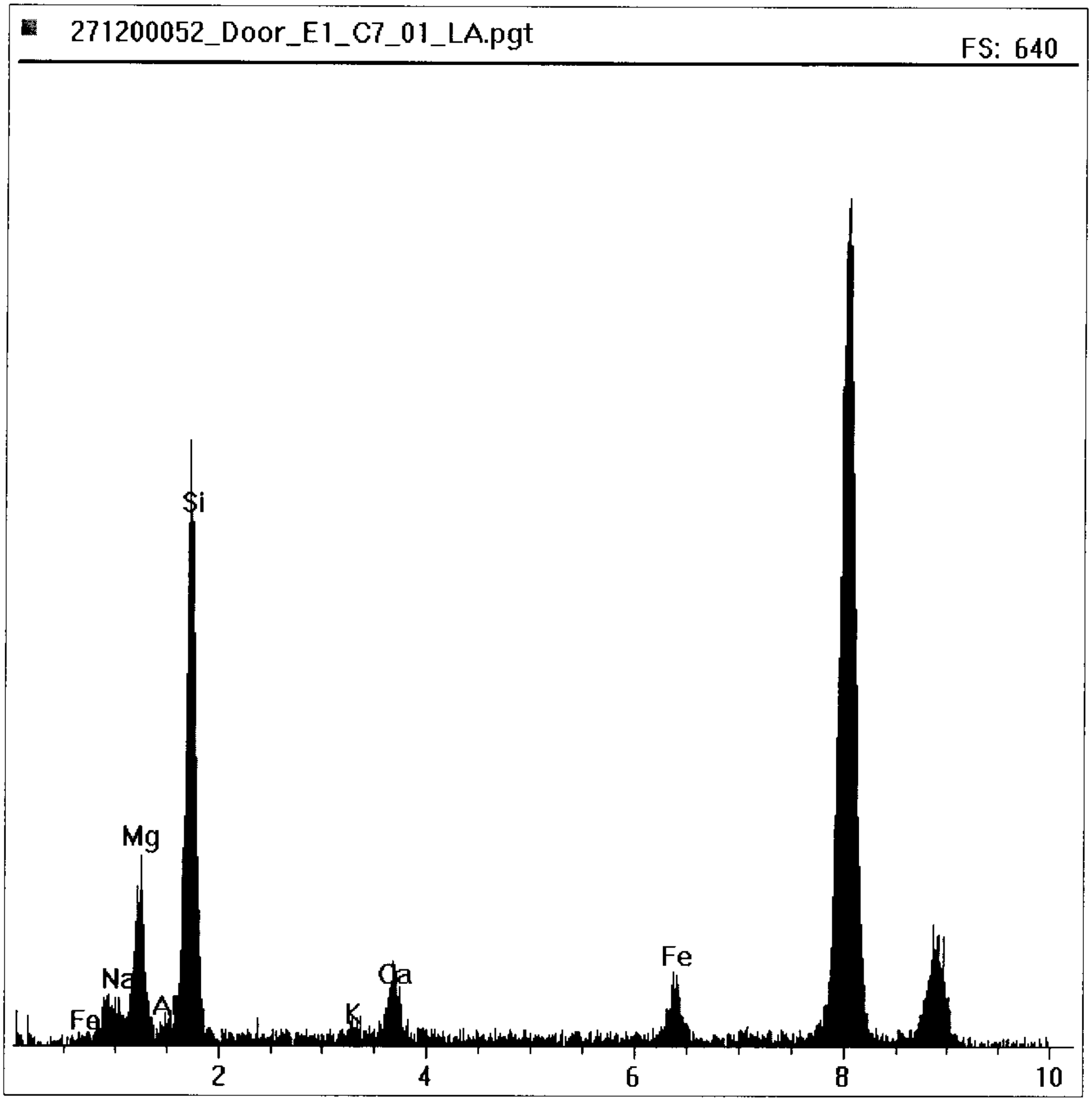
EJRP 3/22/2012

Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...\EMSL27-2\EMSL27-2 2012\271200052_Door_E1_C7_01_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	59.06	Count Rate:	1640	Dead Time:	40.63 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

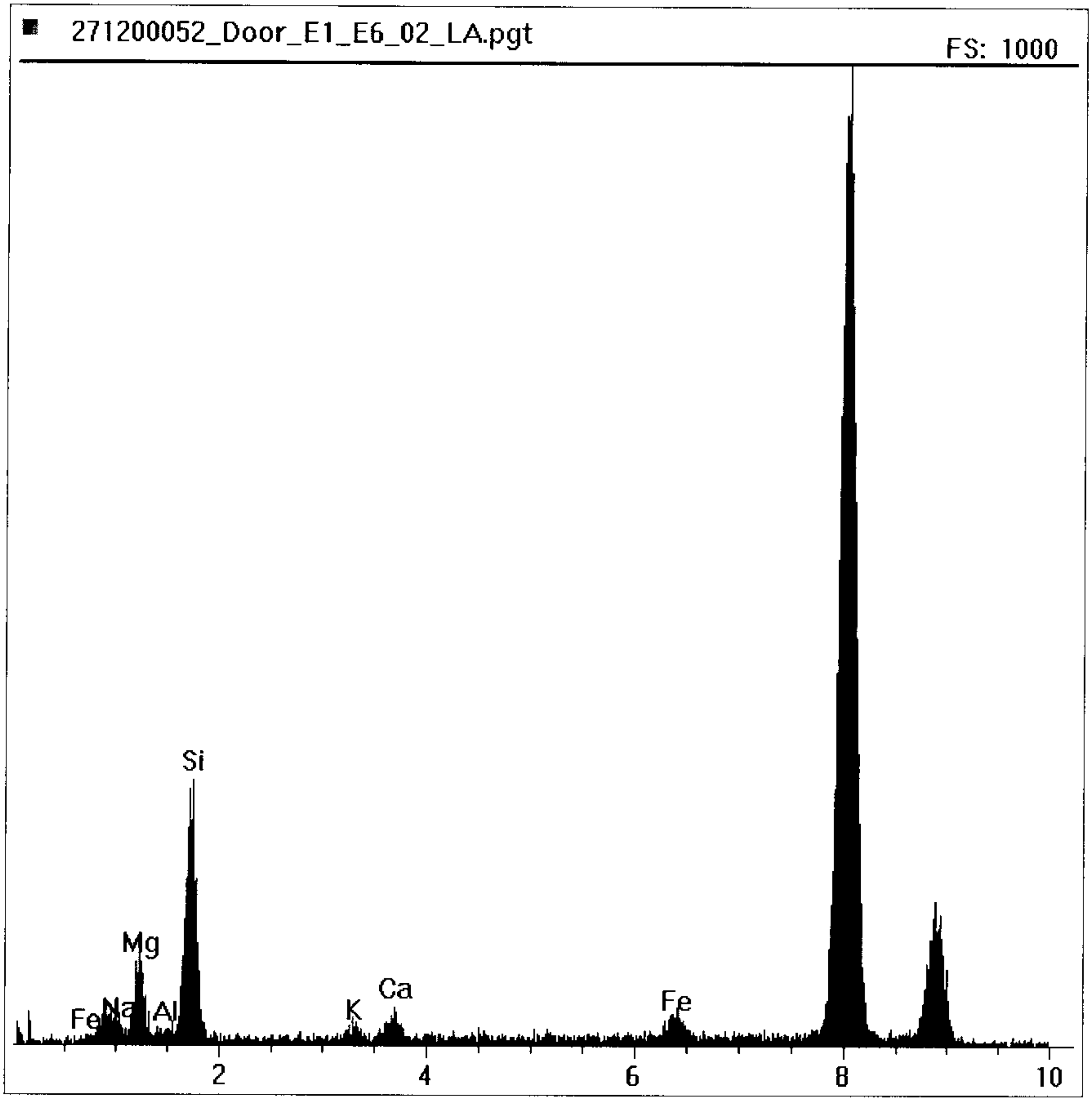


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...\EMSL27-2\EMSL27-2 2012\271200052_Door_E1_E6_02_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	115.47	Count Rate:	1146	Dead Time:	38.58 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

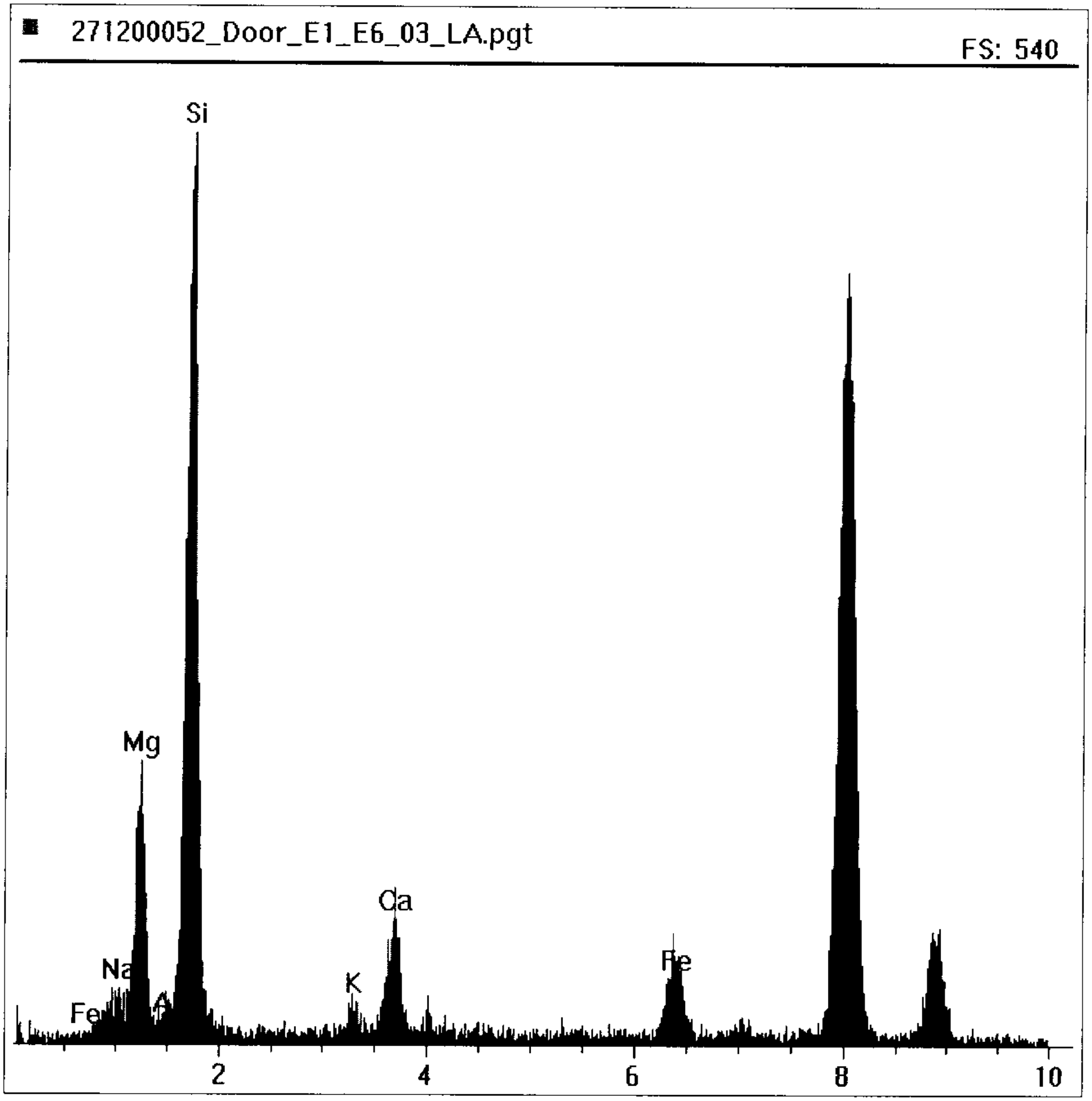


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...\EMSL27-2\EMSL27-2 2012\271200052_Door_E1_E6_03_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	36.27	Count Rate:	2880	Dead Time:	48.32 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

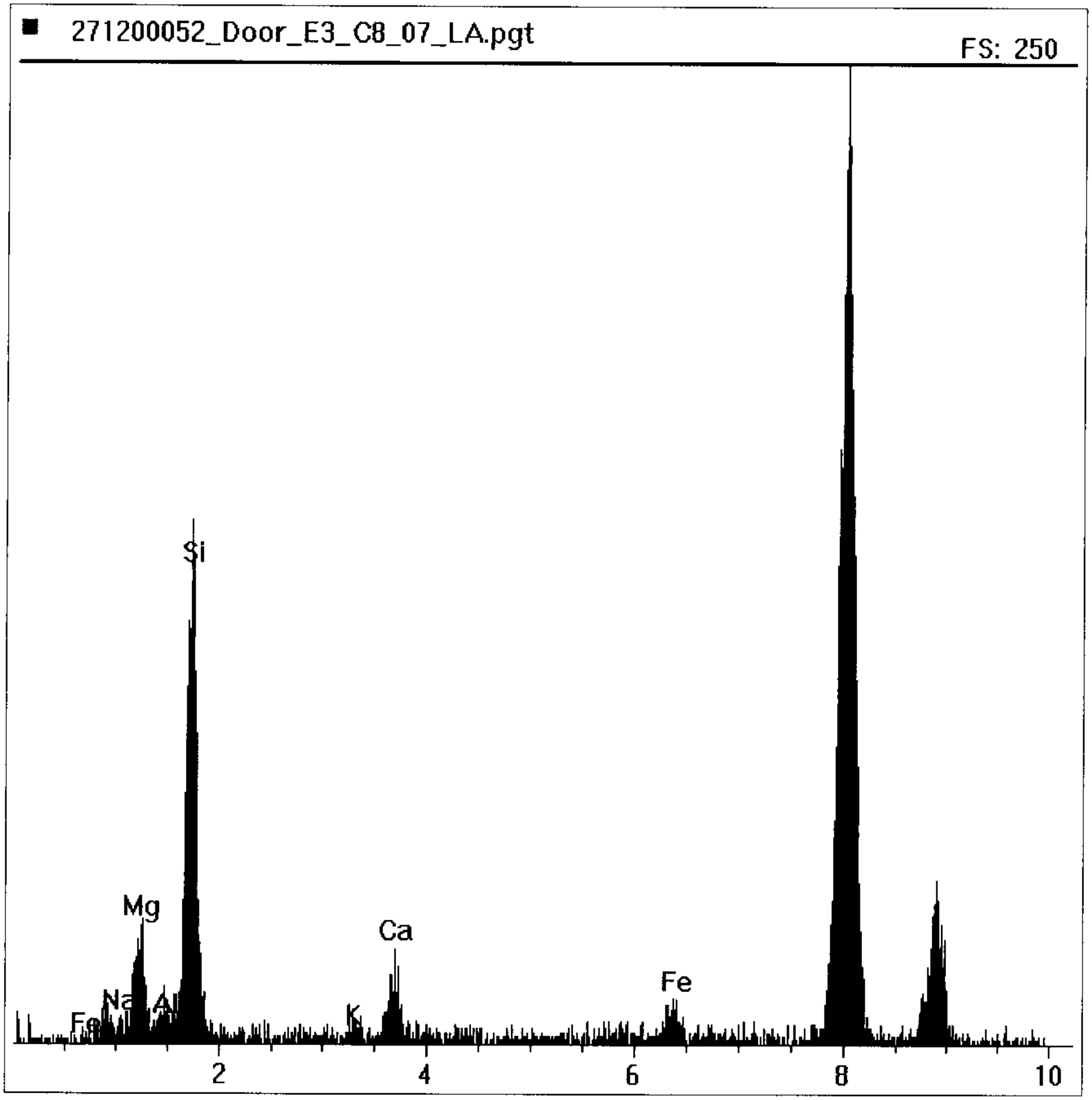


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...\EMSL27-2\EMSL27-2 2012\271200052_Door_E3_C8_07_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	62.29	Count Rate:	583	Dead Time:	33.91 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

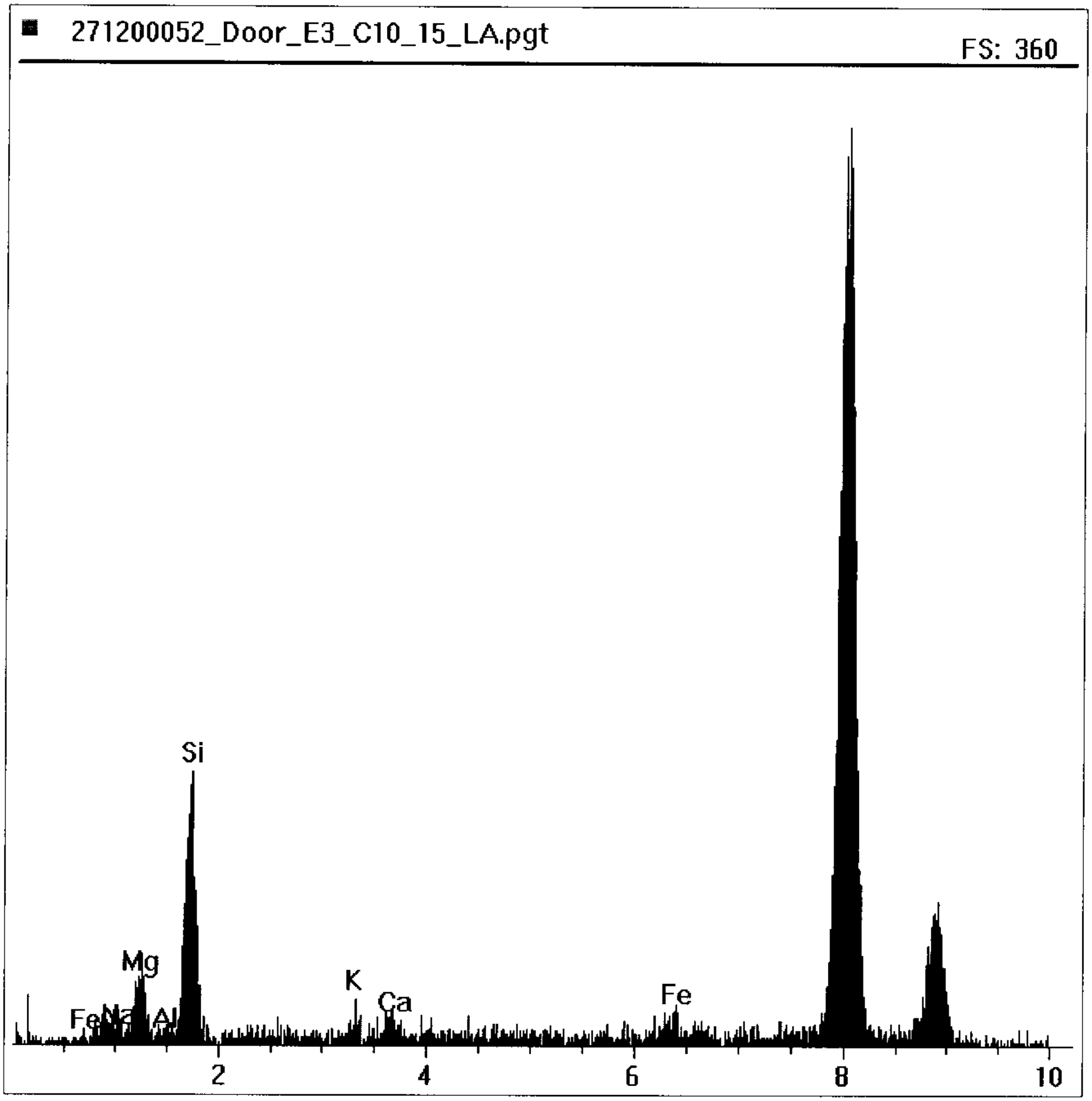


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...EMSL27-2\EMSL27-2 2012\271200052_Door_E3_C10_15_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	72.42	Count Rate:	676	Dead Time:	35.29 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98



Page 1 of 2

LIBBY SITE
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	385
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.1 ~~0.2~~ 3/23/12

EPA Sample Number:	Window
Sample Type (A=Air, D=Dust, DF = Dustfall):	WIPE
Air volume (L), dust area (cm2), or dustfall container area (cm2)	
Date received by lab	2/27/2012
Lab Job Number:	271200052
Lab Sample Number:	271200052-0006
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	3/5/2012
EPA COC Number:	RN990272.0014 00001
Secondary filter pore size (um)	

Analyzed by	E.Wyatt-Pescador
Analysis date	3/22/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	
Estimated particulate loading on filter (%)	5
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-36
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right----->

Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

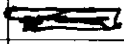
Minimum Width (um): none

Stopping Rules:

Target Sensitivity:

Max # of GOs: 10

Target # of Structures: 25

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
F2	B8	F	1	1	2.50	0.45	AOX	1				 NaK WKTA	1	27279 27280		
	B10	F	2	2	30.00	2.75	AOX	1				 NaK WKTA	1		1	
	D6	F	3	3	17.75	1.75	AOX	1				 NaK WKTA	1		1	
		F	4	4	4.75	0.10	AOX	1				 NaK WKTA	1			
	D8	ND														
	D10	F	5	5	0.70	0.20	AOX	1				 NaK WKTA	1			
		F	6	6	1.60	0.25	AOX	1				 NaK WKTA	1			
		F	7	7	5.20	0.40	AOX	1				 NaK WKTA	1		1	
F4	C9	F	8	8	5.80	0.25	AOX	1				 NaK WKTA	1		1	
	F4	F	9	9	1.65	0.20	AOX	1				 NaK WKTA	1		1	

F-factor Calculation:

Indirect Prep Inputs

1.0	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
500	First resuspension volume or rinsate volume (mL)
25	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

LA = Libby-type amphibole

OA = Other (non-Libby type) amphibole

C = Chrysotile

NAM = Non-asbestos material

Grid opening traverse direction (circle one):
H Horizontal
[✓ V Vertical]

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

If No, explain

LIBBY SITE

TEM Asbestos Structure Count

LAB NAME: EMSL27

LAB SAMPLE NO.: 271200052-0006

EPA SAMPLE NO.: Window

SAMPLE TYPE: WIPE

QA TYPE: Not QA

LAB JOB NUMBER: 271200052

GRID STORAGE LOC.: 2712-REM-36

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Sketch/Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
F4	F6	F	10	10	4.50	0.40	AOX	1				 NaK WRTA	1			
		F	11	11	2.00	0.30	AOX	1				 NaK WRTA	1			
	F8	F	12	12	1.10	0.20	AOX	1				 NaK WRTA	1			
	F10	ND														

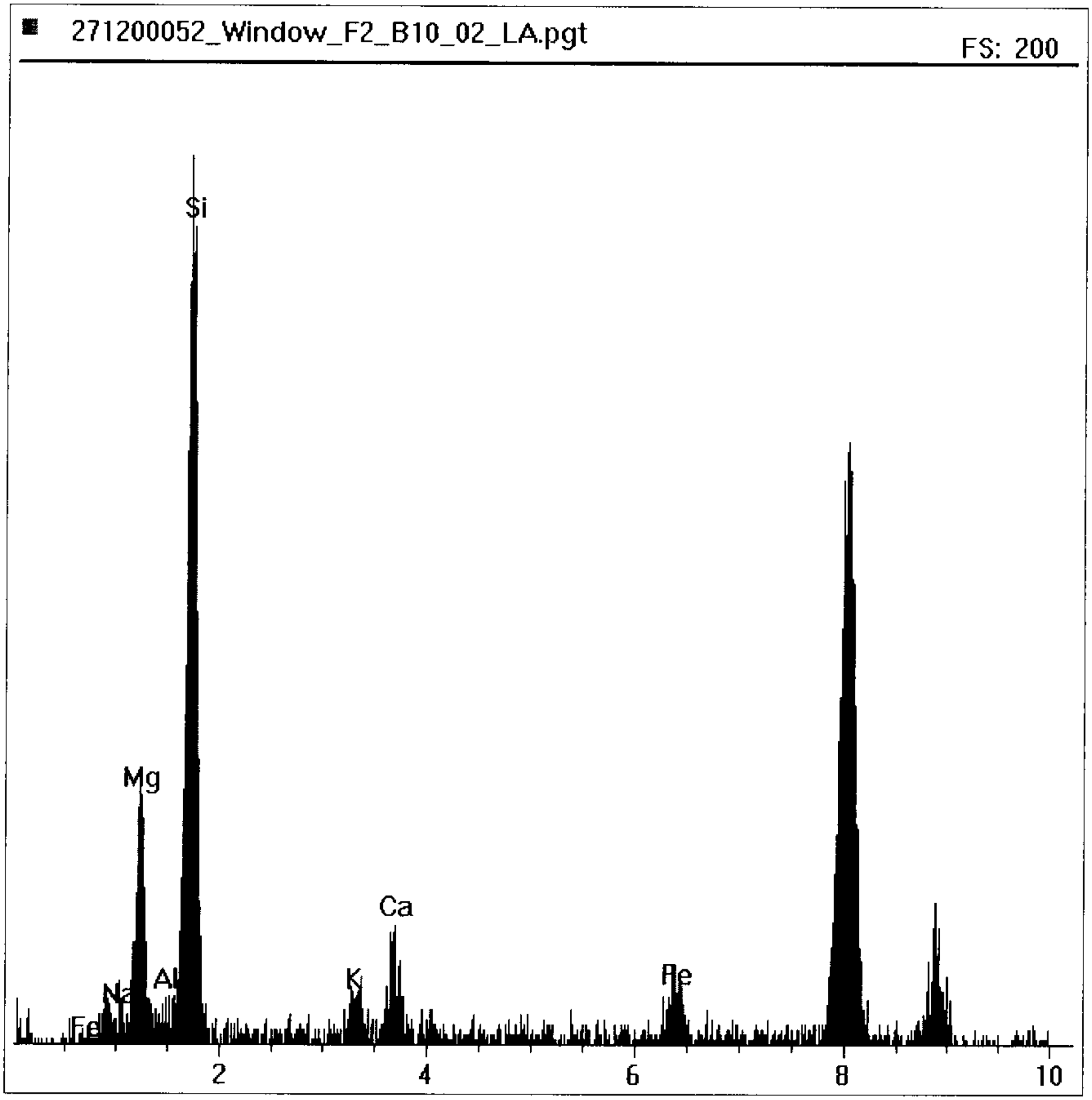
3/22/2012

Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...SL27-2\EMSL27-2 2012\271200052_Window_F2_B10_02_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	31.40	Count Rate:	1015	Dead Time:	35.48 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

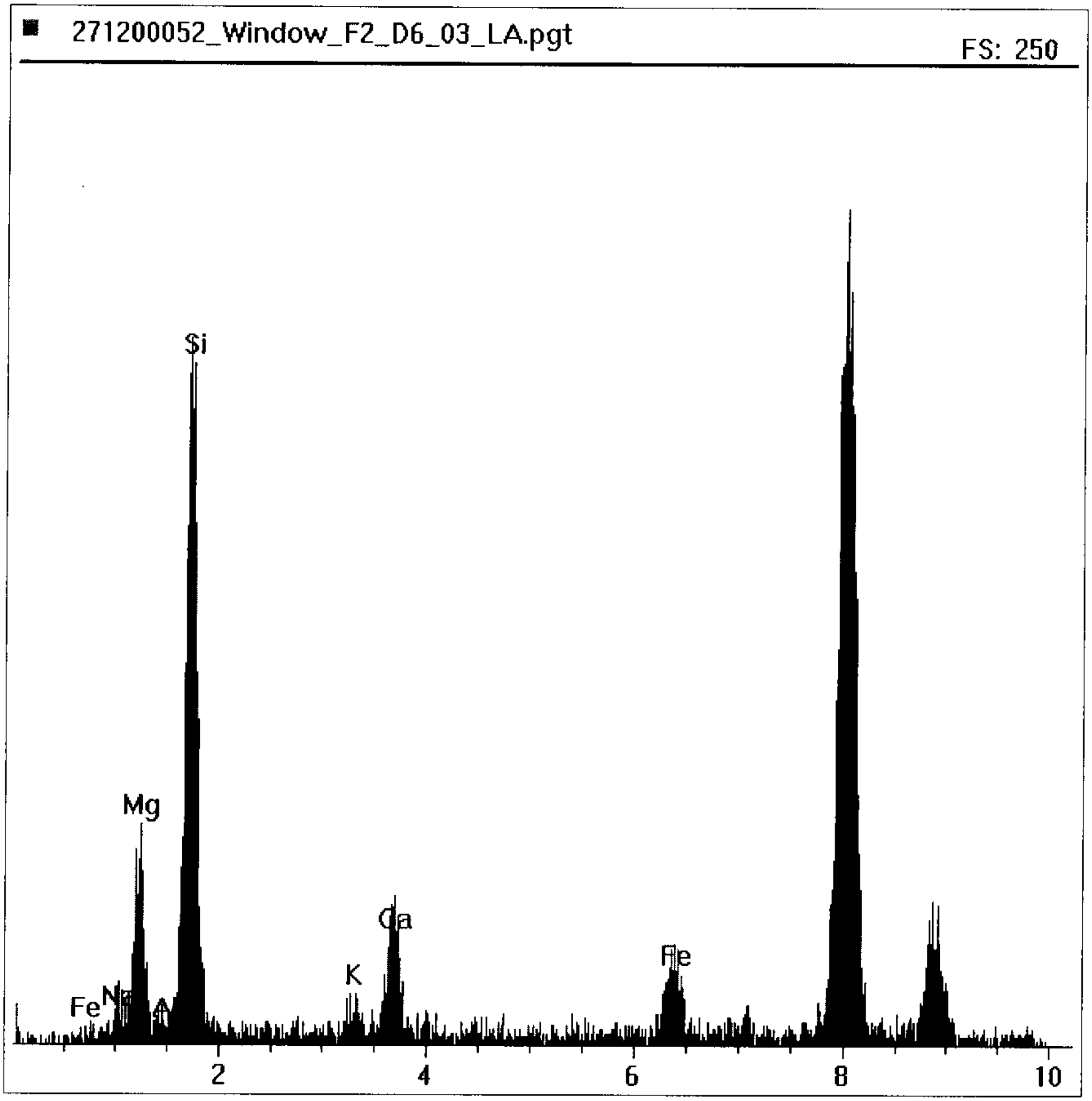


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...MSL27-2\EMSL27-2 2012\271200052_Window_F2_D6_03_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	11.76	Count Rate:	3980	Dead Time:	54.51 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

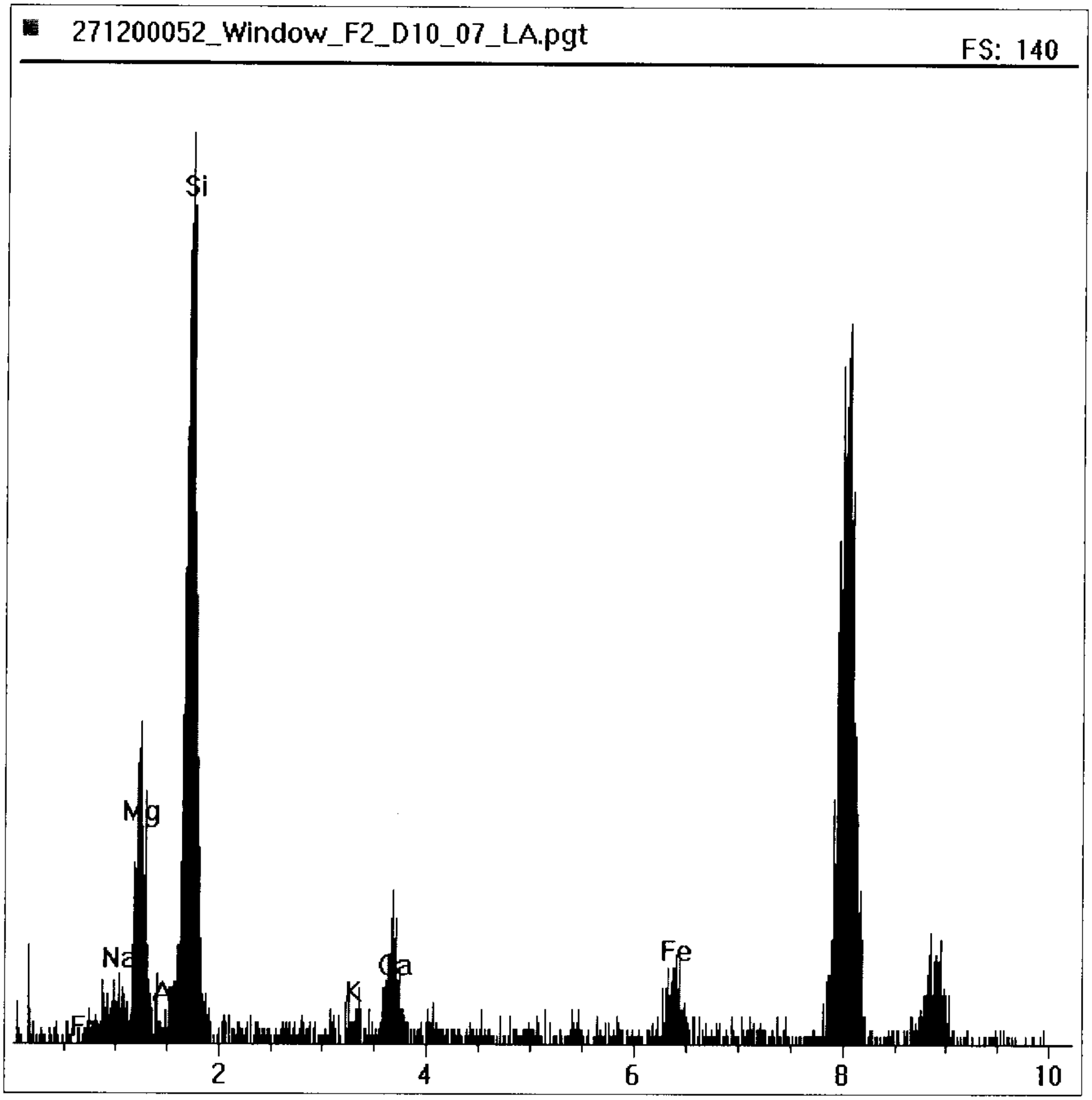


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...SL27-2\EMSL27-2 2012\271200052_Window_F2_D10_07_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	35.98	Count Rate:	691	Dead Time:	34.72 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

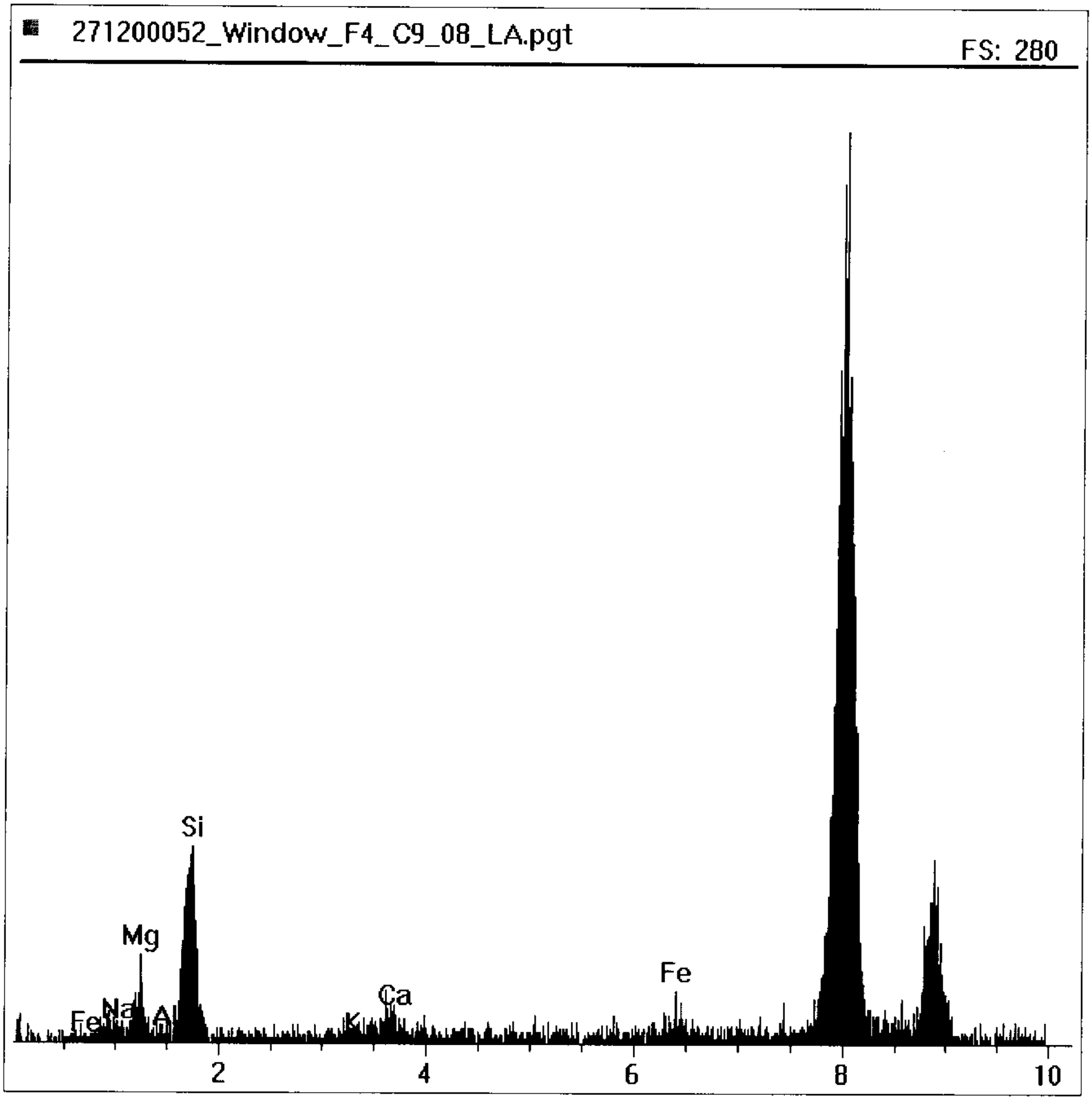


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File: F:\Documen...MSL27-2\EMSL27-2 2012\271200052_Window_F4_C9_08_LA.pgt
Collected: March 21, 2012 10:12:10

Live Time:	12.02	Count Rate:	3132	Dead Time:	78.79 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98

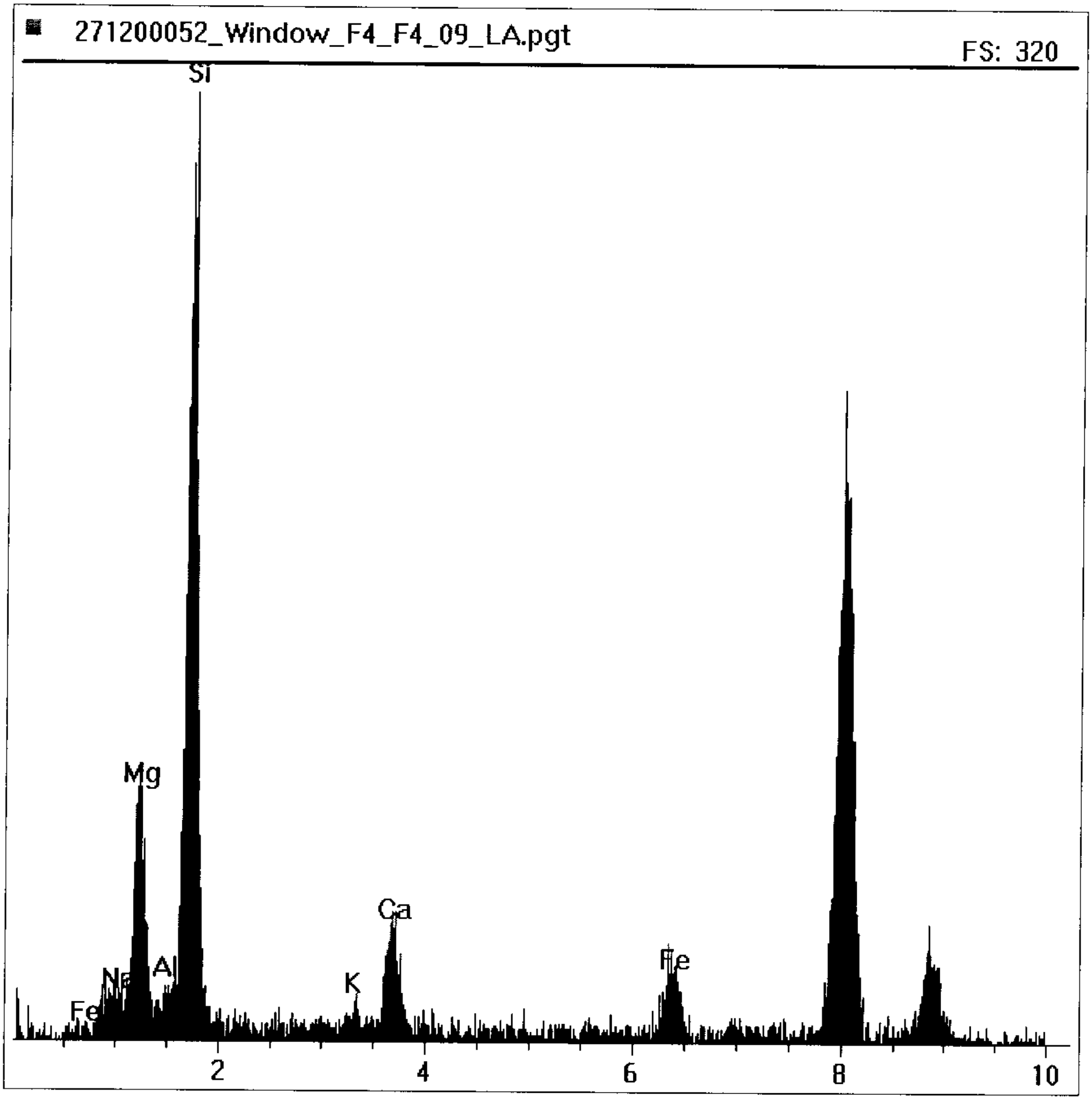


Energy Dispersive X-Ray Analysis
Qualitative Spectrum

EMSL ANALYTICAL, INC.

File:	F:\Documen...MSL27-2\EMSL27-2 2012\271200052_Window_F4_F4_09_LA.pgt
Collected:	March 21, 2012 10:12:10

Live Time:	17.54	Count Rate:	3225	Dead Time:	49.25 %
Beam Voltage:	20.00	Beam Current:	2.00	Takeoff Angle:	57.98



LIBBY SITE
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	385
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.1 ~~0.2~~

EPA Sample Number:	Top
Sample Type (A=Air, D=Dust, DF = Dustfall):	WIPE
Air volume (L), dust area (cm2), or dustfall container area (cm2)	
Date received by lab	2/27/2012
Lab Job Number:	271200052
Lab Sample Number:	271200052-0007
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	3/5/2012
EPA COC Number:	RN990272.0014 00001
Secondary filter pore size (um)	

Analyzed by	E.Wyatt-Pescador
Analysis date	3/22/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	
Estimated particulate loading on filter (%)	4
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-36
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right---->

Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

Minimum Width (um): none

Stopping Rules:

Target Sensitivity:

Max # of GOs: 10

Target # of Structures: 25

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
G1	C2	ND														
	C4	ND														
	C6	ND														
	C8	ND														
	C10	ND														
G3	B2	ND														
	B4	ND														
	B6	ND														
	B8	ND														
	B10	ND														

LA = Libby-type amphibole

OA = Other (non-Libby type) amphibole

C = Chrysotile

NAM = Non-asbestos material

F-factor Calculation:

Indirect Prep Inputs

1.0	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
500	First resuspension volume or rinsate volume (mL)
25	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

Grid opening traverse direction (circle one).
H Horizontal
[✓ V] Vertical

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

If No, explain.

INTERNAL CHAIN OF CUSTODY

3/2/2012 4:27:05 PM

Order ID: 271200062

Attn: Robert Marriam
Remedium Group, Inc.
Subsidiary of W.R. Grace
6401 Poplar Avenue, Suite 301
Memphis, TN 38119

Fax: (901) 820-2061 Phone: (901) 820-2023

Project: **RN990272.003 00001**

Customer ID: REME44
Customer PO:
Received: 03/02/12 2:10 PM

EMSL Order: 271200062
EMSL Proj ID: Burn House
Cust COC ID

Test: **TEM 6480** **Matrix** Wipe **TAT:** 2 Week **Qty:** 1

Acct Sts: N30 **Slsprsn:** rdemalo **Logged:** rmahoney **Date:** 3/2/2012

Inter- Lab Sample Transfer

Samples Relinquished: Date
Samples Received: Date
Package Mailed to Westmont: Date
Method of Delivery:
Includes: (Circle)
Benchsheets Sample Slides Sample filters
Micrographs GridBox Other

Final Package Received: Date:

Sample Condition: ☒ Acceptable ☐ Unacceptable

Comments

Initial Prep (Initials/Lab): DB **Date:** 3/5/2012
Filter Prep (Initials/Lab): DB **Date:** 3/5/2012
Grid Prep (Initials/Lab): DB **Date:** 3/15/2012

For Special Projects Use Only

QC Selection: Date:
Date Package Review: Date:
Date Package Mailed: Date:

Special Instructions

Order ID	Lab Sample #	Cust. Sample #	Location	Due Date
271200062	271200062-0001	Wipe sample burn hut		3/16/2012 2:10:00 PM

REM
2712-~~GTB~~-36 (I-J)

3/17/12

ARCADIS

4915 Prospectus Drive
Durham, NC 27713
(919) 544-4535
FAX (919) 544-5690

Report to:
Dr. Dahman Touati

Bill to: Arcadis

Chain of Custody Record

27/200062

PROJECT NUMBER
RN990272.0003 00001

PO#

PROJECT NAME
Burn hut #1 outlet duct Libby asbestos burn

COLLECTED BY *(SIGNATURE)*
S.Terll

LABORATORY
EMSL Analytical Inc.107 Fourth St.
Libby, Mt 59923

AB LADDRESS

REPORT FORMAT *(CIRCLE ALL REQUIRED)*
ELECTRONIC/VERBAL/FAX/HARDCOPY

FIELD SAMPLE ID	RUSH FACTOR	SAMPLE MATRIX	DATE/ TIME	No. of Containers								REMARKS	LAB ID NO. (for lab use only)
Wipe sample burn hut sheetrock			3-1-2012	1								12"x12" sheetrock behind foil	[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]
													[redacted]

EMSL27 INDIRECT PREPARATION RECORD

EMSL Analytical Inc., Libby, MT

Order ID: 271200062

Date: 3/5/2012

Circle One: TEM Air [✓ TEM Dust] PCM wipes

EFA: 360 mm²

Prepared By: DB

Sample #	Loose Material	Ashed Samples Resuspension with Ashing			Non-Ashed Samples Resuspension without Ashing			Serial Dilution Filtration 2nd resuspension			Serial Dilution Filtration 3rd resuspension			Prepared for Analysis
		Filter Fraction	Resuspended volume	Vol. applied to filter	wipe DB 3/23/12 ~~Filter~~ Fraction	Resuspended volume	Vol. applied to filter	Vol. of 1st resuspension used	Resuspend volume	Vol. applied to filter	Vol of 2nd resuspension used	Resuspend volume	Vol. applied to filter	
	Y/N	fraction	mL	mL	fraction	mL	mL	mL	mL	mL	mL	mL	mL	Y/N
wipe sample Burn Hut	Y				1	500	10	Analyzed						Y
wif					1	250	250							

DB 3/23/12

PC 0.1µm

Locally Controlled Document
Confidential Business Information/Property of EMSL Analytical, Inc

EMSL Analytical, Inc.
107 West 4th Street, Libby, MT 59923
Phone: (406) 293-9066 Fax: Email: mobileasbestoslab@emsl.com

Attn: **Robert Marriam**
Remedium Group, Inc.
Subsidiary of W.R. Grace
6401 Poplar Avenue, Suite 301
Memphis, TN 38119

Fax: (901) 820-2061 Phone: (901) 820-2023
Project: **RN990272.003 00001**

Customer ID: REME44
Customer PO:
Received: 03/02/12 2:10 PM
EMSL Order: 271200062

EMSL Proj: Burn House
Analysis Date: 3/22/2012

Test Report: Asbestos Analysis of Wipe Samples Using Method ASTM 6480-05

SAMPLE ID	AREA SAMPLED (cm^2)	ASBESTOS TYPE	ASBESTOS STRUCTURES	Sensitivity (str/cm^2)	CONCENTRATION (str/cm^2)	COMMENTS
Wipe sample burn hut sheet rock *271200062-0001*	929	None Detected	<2.99	149	<446	

Initial report from 03/23/2012 18:16:06

Analyst(s)

Roy Pescador (1)

R.K. Mahoney
R. K. Mahoney, Laboratory Manager
or other approved signatory

Samples received in good condition unless otherwise noted.
Samples analyzed by EMSL Analytical, Inc. Libby, MT

THIS IS THE LAST PAGE OF THE REPORT.

LIBBY SITE
TEM Asbestos Structure Count

Laboratory name:	EMSL27
Instrument	JEOL 100 CX II (27-2)
Voltage (KV)	100
Magnification	19,000 X
Grid opening area (mm2)	0.013
Scale: 1L =	1
Scale: 1D =	1
Primary filter area (mm2)	385
Secondary Filter Area (mm2)	360
Category (Field, Rep., Dup., Blank)	Field
Primary filter pore size (um)	0.2

EPA Sample Number:	Wipe Sample Burn Hut Sheetrock
Sample Type (A=Air, D=Dust, DF = Dustfall):	WIPE
Air volume (L), dust area (cm2), or dustfall container area (cm2)	
Date received by lab	3/2/2012
Lab Job Number:	271200062
Lab Sample Number:	271200062-0001
Number of grids prepared	5
Prepared by	D. Barney
Preparation date	3/5/2012
EPA COC Number:	RN990272.0003 00001
Secondary filter pore size (um)	

Analyzed by	E.Wyatt-Pescador
Analysis date	3/22/2012
Method (D=Direct, I=Indirect, IA=Indirect, ashed)	D
If sample type = air, is there loose material or debris in the cowl? (Yes, No)	
Estimated particulate loading on filter (%)	20
Counting rules (ISO, AHERA, ASTM)	ISO
Grid storage location	2712-REM-36
Archive filter(s) storage location	Cinnaminson
QA Type (Not QA, Recount Same, Recount Different, Re-prep, Verified Analysis, Reconciliation, Lab Blank, Interlab)	Not QA

F-Factor Calculation (Indirect Preps Only):

Enter data in appropriate cells provided to the right----->

Recording Rules:

Minimum Aspect Ratio (circle one): none [✓ ≥ 3:1] ≥ 5:1

Minimum Length (um): 0.5

Minimum Width (um): none

Stopping Rules:

Target Sensitivity:

Max # of GOs: 10

Target # of Structures: 25

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class (see below)				Sketch/ Comments	1 = yes, blank = no			Fract. GO Chrys.
			Primary	Total	Length	Width		LA	OA	C	NAM		Sketch	Photo	EDS	
I1	E2	ND														
	E4	ND														
	E6	ND														
	E8	ND														
	E10	ND														
I3	F2	ND														
	F4	ND														
	F6	ND														
	F8	ND														
	F10	ND														

F-factor Calculation:

Indirect Prep Inputs

1.0	Fraction of primary filter used for indirect prep or ashing *[For dust and dustfall, enter 1.0]*
500	First resuspension volume or rinsate volume (mL)
10	Volume applied to secondary filter (mL) or used for serial dilution

Inputs for Serial Dilutions

	Second resuspension volume (mL)
	Volume applied to secondary filter (mL) or used for serial dilution
	Third resuspension volume (mL)
	Volume applied to secondary filter (mL)

Input for Ashing of Secondary Filter

	Fraction of secondary filter used for ashing

LA = Libby-type amphibole

OA = Other (non-Libby type) amphibole

C = Chrysotile

NAM = Non-asbestos material

Grid opening traverse direction (circle one):
H Horizontal
[✓ V] Vertical

Are prepped grids acceptable for analysis? (circle one) [✓ Yes] No

If No, explain:

APPENDIX E

Proximate and Ultimate Analysis of Duff and Ash

Laboratory Report

Report prepared for:

Dr Dahman Touati
Arcadis US Inc
Ste F
4915 Prospectus Dr
Durham, NC 27713
Phone: 919-541-3662
Fax: 919-544-5690
Email: dtouati@arcadis-us.com

Report prepared by:

Debbie S Robertson

Purchase Order:

For further assistance, contact:

Debbie S Robertson
Report Production Coordinator
PO Box 51610
Knoxville, TN 37950-1610
(865) 546-1335
debbierobertson@galbraith.com

Sample: Duff Sample
Lab ID: 2012-Q-7299 **Received:** 2012-03-28

Analysis	Method	Result	Basis	Amount	Date (Time)
115: Ash					
	ASTM D3174-11	36.34 %	Dried and Ground	1056.73 mg	2012-03-30
302: Loss on Drying (LOD)					
	ASTM D3173-11	9.00 %	As Received	100.20 g	2012-03-28
810: Volatile Matter					
	ASTM D3175-11	49.65 %	Dried and Ground	1056.73 mg	2012-03-30
811: Fixed Carbon (Calculated)					
	Calculation	14.01 %	Dried	Calculation	2012-04-03
C : Carbon					
	GLI Procedure ME-12	34.064 %	Dried and Ground	2.503 mg	2012-03-30
	GLI Procedure ME-12	34.165 %	Dried and Ground	2.418 mg	2012-03-30
Cl : Chlorine					
	GLI Procedure ME-4A	240 ppm	Dried and Ground	505.95 mg	2012-04-02
d08: Oxygen by difference					
	Calculation	27.47 %	Dried	Calculation	2012-04-03
H : Hydrogen					
	GLI Procedure ME-12	4.140 %	Dried and Ground	2.503 mg	2012-03-30
	GLI Procedure ME-12	4.133 %	Dried and Ground	2.418 mg	2012-03-30
N : Nitrogen					
	GLI Procedure ME-12	0.970 %	Dried and Ground	2.503 mg	2012-03-30
	GLI Procedure ME-12	0.856 %	Dried and Ground	2.418 mg	2012-03-30
S : Sulfur					
	GLI Procedure E16-2	< 0.05 %	Dried and Ground	177.19 mg	2012-03-30
ZZY: Grind					

GLI Procedure G-8	Completed	Dried	Direct	2012-03-29

Signatures:

Published By: Debbie.S.Robertson 2012-04-03T21:15:51.45-04:00

- Physical signatures are on file.
- "Published By" signature indicates authorized release of data.

Laboratory Report

Report prepared for:
Dr Dahman Touati
Arcadis US Inc
Ste F
4915 Prospectus Dr
Durham, NC 27713
Phone: 919-541-3662
Email: dtouati@arcadis-us.com

Report prepared by:
Pat B Delozier

Purchase Order:
RB70756

For further assistance, contact:
Pat B Delozier
Report Production Coordinator
PO Box 51610
Knoxville, TN 37950-1610
(865) 546-1335
patdelozier@galbraith.com

Sample: Duff Sample Run #EX-LT-ASH-021312
Lab ID: 2012-Q-7949 **Received:** 2012-04-05

Analysis	Method	Result	Basis	Amount	Date (Time)
115: Ash					
	ASTM D3174-11	95.16 %	Dried and Ground	1052.03 mg	2012-04-11
302: Loss on Drying (LOD)					
	ASTM D3173-11	0.75 %	As Received	199.93 g	2012-04-09
810: Volatile Matter					
	ASTM D3175-11	5.39 %	Dried and Ground	1052.03 mg	2012-04-11
C : Carbon					
	GLI Procedure ME-12	1.78 %	Ground	1.791 mg	2012-04-11
Cl : Chlorine					
	GLI Procedure ME-4A	614 ppm	Dried and Ground	506.66 mg	2012-04-11
H : Hydrogen					
	GLI Procedure ME-12	< 0.5 %	Ground	1.791 mg	2012-04-11
N : Nitrogen					
	GLI Procedure ME-12	< 0.5 %	Ground	1.791 mg	2012-04-11
S : Sulfur					
	GLI Procedure E16-2	< 0.5 %	Dried and Ground	42.46 mg	2012-04-10
ZZY: Grind					
	GLI Procedure G-8	Completed	Dried	Direct	2012-04-10

Signatures:

Published By: pat.b.delozier 2012-04-12T21:13:35.223-04:00

- Physical signatures are on file.
- "Published By" signature indicates authorized release of data.

APPENDIX F

Chain of Custody Forms

ARCADIS

4915 Prospectus Drive
Durham, NC 27713
(919) 544-4535
FAX (919) 544-5690

Report to: Dr. Dahman Touati

Bill to: Arcadis

Chain of Custody Record

27101582

PROJECT NUMBER
RN990272.0003 00001

PO#

PROJECT NAME
Burn hut #1 outlet duct Libby asbestos burn

COLLECTED BY *(SIGNATURE)*
S.Terll S Terll

LABORATORY
EMSL Analytical Inc.107 Fourth St.
Libby, Mt 59923

AB LADDRESS

REPORT FORMAT *(CIRCLE ALL REQUIRED)*
ELECTRONIC/VERBAL/FAX/HARDCOPY

FIELD SAMPLE ID	RUSH FACTOR	SAMPLE MATRIX	DATE/ TIME	No. of Containers								REMARKS	LAB ID NO. (for lab use only)
EX-HT-MCE-01A-121911		Filter Cassette	12-19-11	1									
EX-HT-MCE-01B-121911		Filter Cassette	12-19-11	1									
EX-HT-MCE-01C-121911		Filter Cassette	12-19-11	1									
EX-HT-MCE-01D-121911		Filter Cassette	12-19-11	1									

CHAIN OF CUSTODY RECORD

27101585

Project Name	USEPA
Project Location	RTP, NC
Sampling Location	Burn Hut #1 Outlet Duct
Project Number	RN990272.0003
Laboratory	EMSL Analytical, Inc.
Laboratory P.O. #	

Sample ID	Sample Matrix	Analysis Requested
EX-HT-MCE-02A-122211 74.87 dry standard liters	MCE filter cassette	asbestos
EX-HT-MCE-02B-122211 78.92 dry standard liters	MCE filter cassette	asbestos
EX-HT-MCE-02C-122211 75.95 dry standard liters	MCE filter cassette	asbestos
EX-HT-MCE-02D-122211 82.62 dry standard liters	MCE filter cassette	asbestos
EX-HT-ASH-121911	Ash	asbestos
EX-HT-ASH-122211	Ash	asbestos

ORIGINAL

Notes/Comments:

Ash samples should have been sent to EMSL cinnaminson NJ

Relinquished By:	STEVE TERLL SteveTerll	Relinquished By:	Todd Thornton Todd Th
Date/Time:	12/23/11 1200	Date/Time:	12-23-11 13:05
Received By:	Todd Thornton Todd Thornton	Received By:	R.K.Mahoney R.K.Mahoney
Date/Time:	12-23-11 12:00	Date/Time:	12/29/11 1430

ARCADIS U.S., Inc.
4915 Prospectus Drive, Suite F
Durham, North Carolina 27713

Phone Number: (919) 544-4535
Fax Number: (919) 544-5690

CHAIN OF CUSTODY RECORD

271200001

Project Name	USEPA
Project Location	RTP, NC
Sampling Location	Burn Hut #1 Outlet Duct
Project Number	RN990272.0003
Laboratory	EMSL Analytical, Inc.
Laboratory P.O. #	

Sample ID	Sample Matrix	Analysis Requested
EX-MCE Hot Blank-01A-121511 156.54 dry standard liters	MCE filter cassette	asbestos
EX-HT-MCE-03A-122811 48.44 dry standard liters	MCE filter cassette	asbestos
EX-HT-MCE-03B-122811 75.58 dry standard liters	MCE filter cassette	asbestos
EX-HT-MCE-03C-122811 78.72 dry standard liters	MCE filter cassette	asbestos
EX-HT-MCE-03D-122811 70.76 dry standard liters	MCE filter cassette	asbestos
EX-MCE Hot Blank-02A-122911 317.03 dry standard liters	MCE filter cassette	asbestos
EX-HT-ASH-122811	Ash	asbestos

Notes/Comments:

Relinquished By:		Relinquished By:	
Date/Time:	12/30/2011	Date/Time:	
Received By:		Received By:	R.K. Mahoney EMSL
Date/Time:	12·30·11	Date/Time:	1/3/12 1345

ARCADIS U.S., Inc.
4915 Prospectus Drive, Suite F
Durham, North Carolina 27713

Phone Number: (919) 544-4535
Fax Number: (919) 544-5690

CHAIN OF CUSTODY RECORD

271200007

Project Name	USEPA
Project Location	RTP, NC
Sampling Location	Burn Hut #1 Outlet Duct
Project Number	RN990272.0003
Laboratory	EMSL Analytical, Inc.
Laboratory P.O. #	

Sample ID	Sample Matrix	Analysis Requested
EX-IMP Hot Blank-01-121511 64.005 dry standard cubic feet	Impinger DI H2O and DI H2O Rinse	asbestos
EX-HT-IMP-03-122811 36.707 dry standard cubic feet	Impinger DI H2O and DI H2O Rinse	asbestos
EX-IMP Hot Blank-02-122911 37.455 dry standard cubic feet	Impinger DI H2O and DI H2O Rinse	asbestos

Notes/Comments:

Relinquished By:	
Date/Time:	12/30/2011
Received By:	
Date/Time:	12:30:11

Relinquished By:	
Date/Time:	
Received By:	K Bleakley-EMSL
Date/Time:	1/3/2012 8:30

ARCADIS U.S., Inc.
4915 Prospectus Drive, Suite F
Durham, North Carolina 27713

Phone Number: (919) 544-4535
Fax Number: (919) 544-5690

Relinquished: Keri Bleakley
Date: 1/5/12 11:00

Rec'd R.K. Mahony EMSL 1/10/12 1410

Sample Volumes

Standard Conditions of 68°F and 29.92 inches Hg

Run #	Sample Volume, dscf	Sample Volume, dsl
EX-PM2.5 Hot Blank-01-121511	27.438	776.96
EX-PM Hot Blank-01-121511	64.162	1816.87
EX-IMP Hot Blank-01-121511	64.083	1814.63
EX-MCE Hot Blank-01A-121511	5.526	156.54
EX-HT-PM2.5-01-121911	26.527	751.16
EX-HT-PM-01-121911	43.422	1229.57
EX-HT-IMP-01-121911	42.102	1192.20
EX-HT-MCE-01A-121911	2.703	76.56
EX-HT-MCE-01B-121911	2.670	75.64
EX-HT-MCE-01C-121911	2.599	73.63
EX-HT-MCE-01D-121911	2.667	75.55
EX-HT-PM2.5-02-122211	26.598	753.17
EX-HT-PM-02-122211	39.202	1110.08
EX-HT-IMP-02-122211	39.795	1126.87
EX-HT-MCE-02A-122211	2.643	74.87
EX-HT-MCE-02B-122211	2.786	78.92
EX-HT-MCE-02C-122211	2.681	75.95
EX-HT-MCE-02D-122211	2.916	82.62
EX-HT-PM2.5-03-122811	27.171	769.40
EX-HT-PM-03-122811	39.544	1119.76
EX-HT-IMP-03-122811	36.673	1038.46
EX-HT-MCE-03A-122811	1.710	48.44
EX-HT-MCE-03B-122811	2.668	75.58
EX-HT-MCE-03C-122811	2.779	78.72
EX-HT-MCE-03D-122811	2.498	70.76
EX-PM2.5 Hot Blank-02-122911	26.713	756.43
EX-PM Hot Blank-02-122911	39.214	1110.42
EX-IMP Hot Blank-02-122911	37.467	1060.95
EX-MCE Hot Blank-02A-122911	11.191	317.03

CHAIN OF CUSTODY RECORD

Project Name	USEPA
Project Location	RTP, NC
Sampling Location	Burn Hut #1
Project Number	RN990272.0003
Laboratory	EMSL Analytical, Inc.
Laboratory P.O. #	

Sample ID	Sample Matrix	Analysis Requested
BH1-Left Wall	Sponge Wipe	ASTM-6480
BH1-Right Wall	Sponge Wipe	ASTM-6480
BH1-Front Wall	Sponge Wipe	ASTM-6480
BH1-Rear Wall	Sponge Wipe	ASTM-6480
BH1-Ceiling	Sponge Wipe	ASTM-6480
BH1-Floor	Sponge Wipe	ASTM-6480

Notes/Comments:

Relinquished By:	John J. Nash	Relinquished By:	
Date/Time:	2/8/12	Date/Time:	
Received By:		Received By:	
Date/Time:		Date/Time:	

ARCADIS U.S., Inc.
4915 Prospectus Drive, Suite F
Durham, North Carolina 27713

Phone Number: (919) 544-4535
Fax Number: (919) 544-5690

APPENDIX G

Certificates of Accuracy for EPA Protocol Gases

PRAXAIR

Praxair Distribution Mid-Atlantic
145 Shimersville Rd.
Bethlehem, PA 18015
Telephone: (610) 317-1608
Facsimile: (610) 758-8382

DocNumber: 000010098

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

CHEROKEE INSTRUMENTS INC *
901 BRIDGE ST
FUQUAY VARINA NC 275260

Praxair Order Number: 16230993
Customer P. O. Number: 11207
Customer Reference Number:

Fill Date: 3/21/2011
Part Number: NI CD18O5ZE-AS
Lot Number: 917108033
Cylinder Style & Outlet: AS CGA 590
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date: **4/3/2014**
Cylinder Number: **CC350219**

NIST Traceable
Analytical Uncertainty:

17.80	**%**	**CARBON DIOXIDE**	± 1 %
21.60	**%**	**OXYGEN**	± 1 %
	Balance	**NITROGEN**	

Certifcation Information: *Certification Date:* 4/3/2011 *Term:* 36 Months *Expiration Date:* 4/3/2014

This cylinder was certified according to the 1997 EPA Traceability Protocol, Document #EPA-600/R-97/121, using Procedure G1

Do Not Use this Standard if Pressure is less than 150 PSIG

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1 . Component: CARBON DIOXIDE

Requested Concentration: 18 %
Certified Concentration: 17.80 %
Instrument Used: SIEMENS ULTRAMAT 5E SN: D2-412
Analytical Method: NON-DISPERSIVE INFRARED
Last Multipoint Calibration: 3/3/2011

Reference Standard Type: GMIS
Ref. Std. Cylinder # : SA18907
Ref. Std. Conc: 18.09 %
Ref. Std. Traceable to SRM # : 2745
SRM Sample # : 9-C-34
SRM Cylinder # : CAL016063

First Analysis Data: **Date:** 3/25/2011

Z:	0	**R:**	18.1	**C:**	17.8	**Conc:**	17.79
R:	18.1	**Z:**	0	**C:**	17.8	**Conc:**	17.79
Z:	0	**C:**	17.82	**R:**	18.1	**Conc:**	17.81

UOM: % **Mean Test Assay:** 17.797 %

Second Analysis Data: **Date:**

Z:	0	**R:**	0	**C:**	0	**Conc:**	0
R:	0	**Z:**	0	**C:**	0	**Conc:**	0
Z:	0	**C:**	0	**R:**	0	**Conc:**	0

UOM: % **Mean Test Assay:** 0 %

2 . Component: OXYGEN

Requested Concentration: 21.75 %
Certified Concentration: 21.60 %
Instrument Used: SIEMENS OXYMAT 5E S/N F1-111
Analytical Method: PARAMAGNETIC
Last Multipoint Calibration: 3/10/2011

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC14600
Ref. Std. Conc: 22.94%
Ref. Std. Traceable to SRM # : 2659a
SRM Sample # : 71-D-27
SRM Cylinder # : CAL015750

First Analysis Data: **Date:** 4/3/2011

Z:	0	**R:**	22.96	**C:**	21.62	**Conc:**	21.589
R:	22.98	**Z:**	0	**C:**	21.64	**Conc:**	21.609
Z:	0	**C:**	21.64	**R:**	22.98	**Conc:**	21.609

UOM: % **Mean Test Assay:** 21.602 %

Second Analysis Data: **Date:**

Z:	0	**R:**	0	**C:**	0	**Conc:**	0
R:	0	**Z:**	0	**C:**	0	**Conc:**	0
Z:	0	**C:**	0	**R:**	0	**Conc:**	0

UOM: % **Mean Test Assay:** 0 %

Analyzed by:
Robin Morgan

Certified by: MK 4/7/11
Michelle Kostik

PRAXAIR

Praxair Distribution Mid-Atlantic
145 Shimersville Rd.
Bethlehem, PA 18015
Telephone: (610) 317-1608
Facsimile: (610) 758-8382

DocNumber: 000005848

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

CHEROKEE INSTRUMENTS INC *
901 BRIDGE ST
FUQUAY VARINA NC 275260

Praxair Order Number: 14207205
Customer P. O. Number: 10773
Customer Reference Number:

Fill Date: 8/10/2010
Part Number: NI CD9O5E-AS
Lot Number: 917022263
Cylinder Style & Outlet: AS CGA 590
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date: 8/19/2013
Cylinder Number: CC231945

NIST Traceable
Analytical Uncertainty:

9.28	%	CARBON DIOXIDE	± 1 %
8.94	%	OXYGEN	± 1 %
	Balance	NITROGEN	

Certifcation Information: *Certification Date:* 8/19/2010 *Term:* 36 Months *Expiration Date:* 8/19/2013

This cylinder was certified according to the 1997 EPA Traceability Protocol, Document #EPA-600/R-97/121, using Procedure G1

Do Not Use this Standard if Pressure is less than 150 PSIG

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1 . Component: CARBON DIOXIDE

Requested Concentration: 9 %
Certified Concentration: 9.28 %
Instrument Used: SIEMENS ULTRAMAT 5E SN: D2-412
Analytical Method: NON-DISPERSIVE INFRARED
Last Multipoint Calibration: 8/12/2010

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC167398
Ref. Std. Conc: 10.26%
Ref. Std. Traceable to SRM # : 2745
SRM Sample # : 9-C-04
SRM Cylinder # : CAL016031

First Analysis Data: **Date:** 8/19/2010

Z:	0	**R:**	10.26	**C:**	9.28	**Conc:**	9.28
R:	10.26	**Z:**	0	**C:**	9.28	**Conc:**	9.28
Z:	0	**C:**	9.28	**R:**	10.26	**Conc:**	9.28

UOM: % **Mean Test Assay:** 9.28 %

Second Analysis Data: **Date:**

Z:	0	**R:**	0	**C:**	0	**Conc:**	0
R:	0	**Z:**	0	**C:**	0	**Conc:**	0
Z:	0	**C:**	0	**R:**	0	**Conc:**	0

UOM: % **Mean Test Assay:** 0 %

2 . Component: OXYGEN

Requested Concentration: 9 %
Certified Concentration: 8.94 %
Instrument Used: SIEMENS OXYMAT 5E S/N F1-111
Analytical Method: PARAMAGNETIC
Last Multipoint Calibration: 7/22/2010

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC153216
Ref. Std. Conc: 23.01 %
Ref. Std. Traceable to SRM # : 2659a
SRM Sample # : 71-D-07
SRM Cylinder # : CAL015449

First Analysis Data: **Date:** 8/17/2010

Z:	0	**R:**	23.06	**C:**	8.96	**Conc:**	8.943
R:	23.08	**Z:**	0	**C:**	8.96	**Conc:**	8.943
Z:	0	**C:**	8.96	**R:**	23.02	**Conc:**	8.943

UOM: % **Mean Test Assay:** 8.943 %

Second Analysis Data: **Date:**

Z:	0	**R:**	0	**C:**	0	**Conc:**	0
R:	0	**Z:**	0	**C:**	0	**Conc:**	0
Z:	0	**C:**	0	**R:**	0	**Conc:**	0

UOM: % **Mean Test Assay:** 0 %

Analyzed by:

Ashley Davila

Certified by: 8/20/10

Michelle Kostik

PRAXAIR

Praxair Distribution Mid-Atlantic
145 Shimersville Rd.
Bethlehem, PA 18015
Telephone: (610) 317-1608
Facsimile: (610) 758-8382

DocNumber: 000013650

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

CHEROKEE INSTRUMENTS INC *
901 BRIDGE ST
FUQUAY VARINA NC 275260

Praxair Order Number: 17906415
Customer P. O. Number: 11496
Customer Reference Number:

Fill Date: 9/21/2011
Part Number: NI CO900E-AS
Lot Number: 917126432
Cylinder Style & Outlet: AS CGA 350
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date:	**10/3/2014**		NIST Traceable
Cylinder Number:	CC176394		Analytical Uncertainty:
899	ppm	**CARBON MONOXIDE**	± 1 %
	Balance	**NITROGEN**	

Certifcation Information: *Certification Date:* 10/3/2011 *Term:* 36 Months *Expiration Date:* 10/3/2014

This cylinder was certified according to the 1997 EPA Traceability Protocol, Document #EPA-600/R-97/121, using Procedure G1

Do Not Use this Standard if Pressure is less than 150 PSIG

PGVP ID# F12011

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1 . **Component: CARBON MONOXIDE**

Requested Concentration: 900 ppm
Certified Concentration: 899 ppm
Instrument Used: HORIBA VIA-3000 S/N Y9EY78L6
Analytical Method: NDIR
Last Multipoint Calibration: 9/22/2011

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC239391
Ref. Std. Conc: 990 PPM
Ref. Std. Traceable to SRM # : 1680b
SRM Sample # : 2-I-05
SRM Cylinder # : CAL015744

First Analysis Data:						**Date:**	9/26/2011
Z:	0	**R:**	987	**C:**	897	**Conc:**	900.03
R:	987	**Z:**	0	**C:**	897	**Conc:**	900.03
Z:	0	**C:**	896	**R:**	986	**Conc:**	899.03
UOM:	PPM			**Mean Test Assay:**			899.7 PPM

Second Analysis Data:						**Date:**	10/3/2011
Z:	0	**R:**	990	**C:**	896	**Conc:**	896
R:	993	**Z:**	0	**C:**	896	**Conc:**	896
Z:	0	**C:**	895	**R:**	987	**Conc:**	895
UOM:	PPM			**Mean Test Assay:**			895.67 PPM

Analyzed by: Ashley Davila
Ashley Davila

Certified by:
Robin Morgan

PRAXAIR

Praxair Distribution Mid-Atlantic
145 Shimersville Rd.
Bethlehem, PA 18015
Telephone: (610) 317-1608
Facsimile: (610) 758-8382

DocNumber: 000012276

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

CHEROKEE INSTRUMENTS INC *
901 BRIDGE ST
FUQUAY VARINA NC 275260

Praxair Order Number: 17368288
Customer P. O. Number: 11391
Customer Reference Number:

Fill Date: 7/14/2011
Part Number: NI CO450E-AS
Lot Number: 917119548
Cylinder Style & Outlet: AS CGA 350
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date:		7/26/2014	NIST Traceable
Cylinder Number:		SG9160204	Analytical Uncertainty:
452	ppm	CARBON MONOXIDE	± 1 %
	Balance	NITROGEN	

Certifcation Information: Certification Date: 7/26/2011 Term: 36 Months Expiration Date: 7/26/2014

This cylinder was certified according to the 1997 EPA Traceability Protocol, Document #EPA-600/R-97/121, using Procedure G1

Do Not Use this Standard if Pressure is less than 150 PSIG

PGVP ID#F12011

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1 . **Component: CARBON MONOXIDE**

Requested Concentration: 450 ppm
Certified Concentration: 452 ppm
Instrument Used: HORIBA VIA-3000 S/N Y9EY78L6
Analytical Method: NDIR
Last Multipoint Calibration: 6/30/2011

Reference Standard Type: GMIS
Ref. Std. Cylinder # : SA13841
Ref. Std. Conc: 504 PPM
Ref. Std. Traceable to SRM # : 1680b
SRM Sample # : 2-I-05
SRM Cylinder # : CAL015744

First Analysis Data:						**Date:**	7/19/2011
Z:	0	R:	498	C:	446	Conc:	451.37
R:	498	Z:	0	C:	448	Conc:	453.4
Z:	0	C:	446	R:	498	Conc:	451.37
UOM:	PPM			Mean Test Assay:			452.05 PPM

Second Analysis Data:						**Date:**	7/26/2011
Z:	0	R:	504	C:	451	Conc:	451.6
R:	503	Z:	0	C:	450	Conc:	450.6
Z:	0	C:	451	R:	503	Conc:	451.6
UOM:	PPM			Mean Test Assay:			451.26 PPM

Analyzed by: Ashley Davila
Ashley Davila

Certified by:
Robin Morgan

PRAXAIR

Praxair Distribution Mid-Atlantic
145 Shimersville Rd.
Bethlehem, PA 18015
Telephone: (610) 317-1608
Facsimile: (610) 758-8382

DocNumber: 000013645

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

CHEROKEE INSTRUMENTS INC *
901 BRIDGE ST
FUQUAY VARINA NC 275260

Praxair Order Number: 17906415
Customer P. O. Number: 11496
Customer Reference Number:

Fill Date: 9/20/2011
Part Number: NI CO125E-AS
Lot Number: 917126333
Cylinder Style & Outlet: AS CGA 350
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date: **10/3/2014**
Cylinder Number: **CC42451**

			NIST Traceable Analytical Uncertainty:
125	ppm	CARBON MONOXIDE	± 1 %
	Balance	NITROGEN	

Certifcation Information: *Certification Date:* 10/3/2011 *Term:* 36 Months *Expiration Date:* 10/3/2014

This cylinder was certified according to the 1997 EPA Traceability Protocol, Document #EPA-600/R-97/121, using Procedure G1

Do Not Use this Standard if Pressure is less than 150 PSIG

PGVP ID# F12011

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1. Component: CARBON MONOXIDE

Requested Concentration: 125 ppm
Certified Concentration: 125 ppm
Instrument Used: HORIBA VIA-3000 S/N Y9EY78L6
Analytical Method: NDIR
Last Multipoint Calibration: 9/22/2011

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC239392
Ref. Std. Conc: 195 PPM
Ref. Std. Traceable to SRM # : 1680b
SRM Sample # : 21-I-05
SRM Cylinder # : CAL015749

First Analysis Data:						Date:	9/24/2011
Z:	0	R:	194	C:	125	Conc:	124.79
R:	196	Z:	0	C:	125	Conc:	124.79
Z:	0	C:	125	R:	196	Conc:	124.79
UOM:	PPM					Mean Test Assay:	124.79 PPM

Second Analysis Data:						Date:	10/3/2011
Z:	0	R:	196	C:	126	Conc:	125.36
R:	196	Z:	0	C:	126	Conc:	125.36
Z:	0	C:	126	R:	196	Conc:	125.36
UOM:	PPM					Mean Test Assay:	125.36 PPM

Analyzed by: Ashley Davila
Ashley Davila

Certified by:
Robin Morgan

PRAXAIR

Praxair Distribution Mid-Atlantic
145 Shimersville Rd.
Bethlehem, PA 18015
Telephone: (610) 317-1608
Facsimile: (610) 758-8382

DocNumber: 000012465

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

CHEROKEE INSTRUMENTS INC *
901 BRIDGE ST
FUQUAY VARINA NC 275260

Praxair Order Number: 17368288
Customer P. O. Number: 11391
Customer Reference Number:

Fill Date: 7/26/2011
Part Number: NI CO45ME-AS
Lot Number: 917120746
Cylinder Style & Outlet: AS CGA 350
Cylinder Pressure & Volume: 2000 psig 140 cu. ft.

Certified Concentration:

Expiration Date:	8/8/2014		NIST Traceable
Cylinder Number:	CC169591		Analytical Uncertainty:
45.6	ppm	CARBON MONOXIDE	± 1 %
	Balance	NITROGEN	

Certifcation Information: *Certification Date:* 8/8/2011 *Term:* 36 Months *Expiration Date:* 8/8/2014

This cylinder was certified according to the 1997 EPA Traceability Protocol, Document #EPA-600/R-97/121, using Procedure G1

Do Not Use this Standard if Pressure is less than 150 PSIG

PGVP ID#F12011

Analytical Data: *(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)*

1 . Component: **CARBON MONOXIDE**

Requested Concentration: 45 ppm
Certified Concentration: 45.6 ppm
Instrument Used: HORIBA VIA-3000 S/N Y9EY78L6
Analytical Method: NDIR
Last Multipoint Calibration: 7/30/2011

Reference Standard Type: GMIS
Ref. Std. Cylinder # : CC90276
Ref. Std. Conc: 50.1 PPM
Ref. Std. Traceable to SRM # : 1679c
SRM Sample # : 3-I-37
SRM Cylinder # : FF28502

First Analysis Data:						**Date:**		8/1/2011	
Z:	0	R:	49.8	C:	45.5	Conc:	45.652		
R:	50	Z:	0	C:	45.5	Conc:	45.652		
Z:	0	C:	45.3	R:	50	Conc:	45.451		
UOM:	PPM			Mean Test Assay:			45.585 PPM		

Analyzed by:
Ashley Davila

Second Analysis Data:						**Date:**		8/8/2011
Z:	0	R:	50.2	C:	45.7	Conc:	45.7	
R:	50	Z:	0	C:	45.7	Conc:	45.7	
Z:	0	C:	45.7	R:	50.1	Conc:	45.7	
UOM:	PPM			Mean Test Assay:			45.7 PPM	

Certified by:
Robin Morgan

AIR LIQUIDE Air Liquide America Specialty Gases LLC Scott™

1290 COMBERMERE STREET, TROY, MI 48083 Phone: 248-589-2950 Fax: 248-589-2134

RATA CLASS

Dual-Analyzed Calibration Standard

CERTIFICATE OF ACCURACY: EPA Protocol Gas

Assay Laboratory

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
1290 COMBERMERE STREET
TROY, MI 48083

P.O. No.: 59223-71-65000
Document # : 43354000-002

Customer

CLEAN AIR ENGINEERING
~~DON ALLEN~~
500 WEST WOOD STREET
PALATINE IL 60067
US

ANALYTICAL INFORMATION Gas Type : OC2

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: CC30557
Cylinder Pressure*:** 2000 PSIG
Certification Date: 04Oct2011
Exp. Date: 03Oct2014
Batch No: TRO0043294

COMPONENT	CERTIFIED CONCENTRATION (Moles)	ACCURACY**	TRACEABILITY
OXYGEN	2.07 %	+/- 1%	Direct NIST and VSL
CARBON DIOXIDE	2.10 %	+/- 1%	Direct NIST and VSL
NITROGEN	BALANCE		

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 2350	01Dec2011	K016398	23.20 %	OXYGEN
NTRM 2000	01Jun2013	K026898	5.006 %	CARBON DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
CAI/110P/V03018	15Sep2011	PARAMAGNETIC
VARIAN/3400/10693	16Sep2011	THERMAL CONDUCTIVITY

ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

First Triad Analysis	Second Triad Analysis	Calibration Curve
OXYGEN Date: 04Oct2011 Response Unit: % Z1=0.00000 R1=23.20000 T1=2.09000 R2=23.20000 Z2=0.00000 T2=2.09000 Z3=0.00000 T3=2.09000 R3=23.20000 Avg. Concentration: 2.068 %		Concentration=A+Bx+Cx2+Dx3+Ex4 r=0.999998 Constants: A=-0.02240762 B=1.000309795 C=0 D=0 E=0
CARBON DIOXIDE Date: 05Oct2011 Response Unit: AREA Z1=0.00000 R1=264583.0 T1=110947.0 R2=263017.0 Z2=0.00000 T2=110916.0 Z3=0.00000 T3=110907.0 R3=262998.0 Avg. Concentration: 2.102 %		Concentration=A+Bx+Cx2+Dx3+Ex4 r=0.999993 Constants: A=-0.00267158 B=1.89919E-05 C=0 D=0 E=0

APPROVED BY: JEFF CROTEAU

AIR LIQUIDE Air Liquide America
Specialty Gases LLC Scott™

RATA CLASS

Dual-Analyzed Calibration Standard

1290 COMBERMERE STREET, TROY, MI 48083

Phone: 248-589-2950 Fax: 248-589-2134

CERTIFICATE OF ACCURACY: EPA Protocol Gas

Assay Laboratory

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
1290 COMBERMERE STREET
TROY, MI 48083

P.O. No.: 57661-71-65000
Project No.: 05-80162-025

Customer

CLEAN AIR ENGINEERING
DON ALLEN
500 W. WOOD STREET
PALATINE IL 60067

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: ALM059575 **Certification Date:** 28Sep2009 **Exp. Date:** 27Sep2012
Cylinder Pressure*:** 2000 PSIG

COMPONENT	CERTIFIED CONCENTRATION (Moles)		ANALYTICAL ACCURACY**	TRACEABILITY
CARBON DIOXIDE	1,800	PPM	+/- 1%	
AIR		BALANCE		

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 2619	15Aug2013	ALM060930	5012. PPM	CARBON DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
PIR/2000/609015	28Sep2009	NDIR

ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

First Triad Analysis **Second Triad Analysis** **Calibration Curve**

CARBON DIOXIDE

Date: 28Sep2009	Response Unit:MV	
Z1=0.00000	R1=87.90000	T1=32.00000
R2=87.90000	Z2=0.00000	T2=32.10000
Z3=0.00000	T3=32.10000	R3=87.90000
Avg. Concentration:	1798.	PPM

Concentration=A+Bx+Cx2+Dx3+Ex4
r=0.999995

Constants:	A=-2.0258154
B=54.69753075	C=0.0774588
D=-0.0005099	E=0

APPROVED BY:
JEFF CROTEAU

AIR LIQUIDE Air Liquide America Specialty Gases LLC Scott™

RATA CLASS

Dual-Analyzed Calibration Standard

500 WEAVER PARK RD, LONGMONT, CO 80501 Phone: 888-253-1635 Fax: 303-772-7673

CERTIFICATE OF ACCURACY: EPA Protocol Gas

Assay Laboratory

P.O. No.: 57661-71-65000
Project No.: 08-80873-001

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
500 WEAVER PARK RD
LONGMONT, CO 80501

Customer

CLEAN AIR ENGINEERING
DON ALLEN
500 W. WOOD STREET
PALATINE IL 60067

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: AAL20632 **Certification Date:** 05Oct2009 **Exp. Date:** 04Oct2012
Cylinder Pressure*:** 2000 PSIG

COMPONENT	CERTIFIED CONCENTRATION (Moles)		ANALYTICAL ACCURACY**	TRACEABILITY
CARBON DIOXIDE	1,020	PPM	+/- 1%	Direct NIST and VSL
AIR		BALANCE		

*** Do not use when cylinder pressure is below 150 psig.

** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 2619	15Aug2013	ALM061048	5012. PPM	CARBON DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
HORIBA/AIA-210/4276904010	05Oct2009	NDIR

ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

First Triad Analysis **Second Triad Analysis** **Calibration Curve**

CARBON DIOXIDE

Date: 05Oct2009 Response Unit:VOLTS

Z1=0.00000	R1=0.50100	T1=0.10300
R2=0.50100	Z2=0.00000	T2=0.10300
Z3=0.00000	T3=0.10300	R3=0.50200
Avg. Concentration:	1017.	PPM

Concentration=A+Bx+Cx2+Dx3+Ex4
r=0.999967

Constants:	A=-0.00177553
B=1.004829842	C=
D=	E=

APPROVED BY: JW
JON WITZAK

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1290 COMBERMERE STREET, TROY, MI 48083 Phone: 248-589-2950 Fax: 248-589-2134

RATA CLASS

Dual-Analyzed Calibration Standard

CERTIFICATE OF ACCURACY: EPA Protocol Gas

Assay Laboratory

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
1290 COMBERMERE STREET
TROY, MI 48083

P.O. No.: 57534-71-65000
Project No.: 05-78153-006

Customer

CLEAN AIR ENGINEERING
DON ALLEN
500 W. WOOD STREET
PALATINE IL 60067

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: AAL9103 **Certification Date:** 27Jul2009 **Exp. Date:** 26Jul2012

Cylinder Pressure*:** 2000 PSIG

COMPONENT	CERTIFIED CONCENTRATION (Moles)	ANALYTICAL ACCURACY**	TRACEABILITY
CARBON DIOXIDE	4.89 %	+/- 1%	Direct NIST and NMi
OXYGEN	5.00 %	+/- 1%	Direct NIST and NMi
NITROGEN	BALANCE		

*** Do not use when cylinder pressure is below 150 psig.

** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 2300	01Nov2010	1D002807	23.04 %	CARBON DIOXIDE
NTRM 2350	01Dec2011	K016398	23.20 %	OXYGEN

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
PIR/2000/609015	16Jul2009	NDIR
CAI/110P/V03018	01Jul2009	PARAMAGNETIC

ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

First Triad Analysis **Second Triad Analysis** **Calibration Curve**

CARBON DIOXIDE

Date: 28Jul2009 Response Unit:MV
Z1=0.00000 R1=102.5000 T1=36.50000
R2=102.5000 Z2=0.00000 T2=36.50000
Z3=0.00000 T3=36.50000 R3=102.5000
Avg. Concentration: 4.888 %

Concentration=A+Bx+Cx2+Dx3+Ex4
r=0.999992
Constants: A=-0.00322681
B=0.136315338 C=-0.0005754
D=1.40219E-05 E=0

OXYGEN

Date: 28Jul2009 Response Unit:%
Z1=0.00000 R1=23.20000 T1=5.01000
R2=23.20000 Z2=0.00000 T2=5.01000
Z3=0.00000 T3=5.01000 R3=23.20000
Avg. Concentration: 5.003 %

Concentration=A+Bx+Cx2+Dx3+Ex4
r=0.999999
Constants: A=-0.00675558
B=0.999864575 C=0
D=0 E=0

APPROVED BY: ______________________
JEFF CROTEAU

APPENDIX H: INTERNAL AUDIT REPORT

August 13, 2012

Project Audited:	Emissions of Amphibole Asbestos from the Simulated Open Burning of Duff from Libby, MT
Project No:	RN990273.0014.00001
Project Location:	Open Burn Testing Facility (OBTF)
Audit Type:	Data Quality
Audit Date:	August 3-10, 2012
WA Leader:	Dahman Touati
EPA WA Manager:	Paul Lemieux
Auditor:	Libby Nessley ARCADIS/ORLS QA Officer

1.0 INTRODUCTION

The goals of these tests were:

- To provide emission factors of LA fibers and PM less than or equal to 2.5 µm ($PM_{2.5}$) to air during a simulated open fire of duff collected from OU3;
- To provide estimates of the partitioning of LA fibers between air emissions and ash; and
- To determine how sensitive the results (both LA and $PM_{2.5}$ release) are to burn temperatures.

The DQO for these tests was that measurements of LA and $PM_{2.5}$ in the residual ash and air emissions should be of sufficient precision and accuracy to allow EPA Region 8 to use the data for an exposure assessment of USFS personnel who might operate in the vicinity of a forest fire near Libby, MT.

The following measurements were deemed to be critical to accomplish the experimental DQO:

- Sample volume (dry basis);
- Exhaust duct volumetric flow rate (dry basis);
- Exhaust duct moisture level;
- Weight of the burned material;
- Run time, including sample times, feed times, and total burn time;
- $PM_{2.5}$ filter weight;
- Concentration of LA associated with $PM_{2.5}$;
- Concentration of LA in the duff that was burned;
- Burn temperatures
- Exhaust duct temperatures

2.0 AUDIT ACTIVITIES

This was an internal audit of data quality (ADQ) performed by the ARCADIS ORLS QA Officer, Libby Nessley. An ADQ requires a detailed review of the recording and transfer of raw data, data calculations, documentation procedures and assessment of data quality indicator goals.

2.1 Audit Preparation

The following documents and information was used to perform the ADQ.

- Draft report titled *Emissions of Amphibole Asbestos from the Simulated Open Burning of Duff from Libby, MT*
- Category I QAPP titled *Detailed QAPP for the Activities at the Burn Chamber Facility*
- Project notebook (#2335)
- Electronic project files provided by the ARCADIS WA Leader

2.2 Audit Scope

This was an internal ADQ performed by the ARCADIS QA Officer. Specific data reported in the draft final report was randomly selected and traced back to the raw data found in the notebooks, on data sheets or in electronic files.

2.3 Audit Activity

This audit concentrated on the data reported in Sections 4 (Results and Discussion) and 5 (Quality Control Evaluation Report) of the draft report. Data was randomly selected from the tables and traced back to its origin in laboratory notebook entries, daily data sheets, electronic files or analytical laboratory reports. In general, approximately 20% of the reported data was reviewed. Copies of spreadsheets used to verify information in the report are included in Attachment 1. Highlighted cells indicate cells that were checked and green means the data matched the report was calculated or transferred correctly, yellow means there is inconsistency in the report or the way the information is calculated in the spreadsheet.

3.0 SUMMARY

It was discovered that there were a number of inconsistencies between the first version of the report (Duff Burn Report r5 072512_DT.docx) that was given to the auditor and the electronic files being used to verify the data. When the ARCADIS WA Leader was asked about the discrepancies, he indicated that the auditor had not received the latest version of the document. At that time the most recent file (Duff Burn Report r5_revised.docx) was sent to the auditor to use for the audit. The auditor also found several duplicated files in different folders in the electronic files. This can be a problem if one goes in to change one file in a specific folder but does not change all the files. In general, document control and file naming/storage procedures could be improved. Specific issues found during the ADQ are detailed in Section 4.

4.0 Audit Results

This sections details specific audit findings and observations. Findings are items which could have an impact on data quality and require corrective action. Observations are items that in the opinion of the auditor do not have a detrimental effect on data quality and do not require a formal response or corrective action.

Finding 1: Discrepancies in electronic files and data reported in tables. Inconsistencies found in Tables 4-1 and 4-4 of the draft report. Using the EX-HT-CEM-Final Analysis.xlsx file, Summary Sheet for HT tests tab to compare the tables with, in Table 4-1, the Total Flue Gas Volume for the first set of data (except the very first 2.06E+06) does not match the electronic file. In Table 4-4, The T4 ant T6 temperatures don't match for the first Pre-Duff Sampling test. Spreadsheets are included in Attachment 1. Green highlighted cells indicate data agreed with that reported in the draft report, yellow highlighted cells indicated the numbers do not agree.

ARCADIS WAL Response: Tables 4-1 and 4-4 were corrected

Finding 2: Isokineticity for PM2.5 for the low temperature blank not pulling from the right

data set. In the Isokineticity calculation (column H) for the files named EX-All Blank-CEM-Final Analysis.xlsx and EX-HT-Blank-CEM-Final Analysis.xlsx, the cell for the EXPM2.5 LT Blank 01-021712 is not pulling the data from the same spreadsheet as the other low temperature samples. Not sure if this is the wrong data from the wrong spreadsheet or if the spreadsheet was not named correctly. This should be corrected. Spreadsheets are included in Attachment 1. Green highlighted cells indicate data agreed with that reported in the draft report, yellow highlighted cells indicated the numbers do not agree.

ARCADIS WAL Response: The spreadsheets were corrected

Finding 3: Having the same file in multiple folders is not good practice. The auditor noticed that there is at least one file that is in multiple folders (EX-All Blanks-CEM-Final Analysis). This is not good practice because if one is changed, the other is not. Prior to archiving the final project file, make sure duplicate files are discarded.

ARCADIS WAL Response: A single folder was created to archive the final project file

Finding 4: There were several instances in Table 5-3 where DQI goals were not met and this is not reflected in completeness. These discrepancies were corrected in the second version of the report that was given to the auditor.

Observation 1: Figure 3-10 should show bag additions to be consistent with Figure 3-9.This was done in the second version of the report that was given to the auditor.

Observation 2: Units need to be consistent or show both English and metric units. This was done in the second version of the report that was given to the auditor.

Observation 4: Equations were not carried through all the temperature cells in spreadsheets. In several of the spreadsheets, temperature data was copied from the cell above. Instead of copying the equation in the cell, the actual temperature was copied and pasted. This was corrected in revised spreadsheets.

Attachment 1

Spreadsheets Reviewed

X-HT-Blank-Cert-Final Analysis.xlsx

Test ID		Sampling train Type	Start Time	End Time	Sample Volume	Total Flue gas Volume	Isokineticity	Moelcuar weight	ample Mas	Temperature at the grate				Temperature 4 inches above the grate		Average CO_2	Average CO	Delta CO2	Delta CO
	Blank		EDT		Dry Standard Liters			g/gmole	Grams	T1	T2	T3	T5	T4	T6	ppmv			
Ambient air			10:43	11:01				28.9		16	19	17	17	19	17	644	0.00		
EX-PM Hot Blank-01-121511 (burner ON)		Impinger sampling Method for Asbestos	13:48	14:48	1814.6	1863854	100	28.9	2177	830	748	826	144	120	672	1845	0	1201	0
EX-Hot blank-PM-01-121511		Total PM sampling using EPA Method 5	13:48	14:48	1816.9	1838951	101	29	2178	830	748	826	144	120	672	1845	0	1201	0
EX-Hot Blank-PM2.5-01-121511		PM 2.5 Sampling using EPA 201a	13:48	14:48	777.0	1860732	110	29	931	830	748	826	144	120	672	1845	0	1201	0
EX-Hot blank-MCE-01B-121511		Asbestos Sampling using SOP-2015	13:55	14:55	156.5	1854512	n-Isokinetic samp	28.8	188	830	748	826	144	120	672	1845	0	1201	0
	urner O																		
EX-PM Air Blank-01-121511		Impinger sampling Method for Asbestos	11:15	12:15	1061.0	1854875	101	28.8	1272										
EX-HT-PM-01-121511		Total PM sampling using EPA Method 5	11:15	12:15	1110.4	1856470	101	29	1331										
EX-HT-PM2.5-01-121511		PM 2.5 Sampling using EPA 201a	11:15	12:15	756.4	1854018	115	28.8	907										
EX-HT-MCE-01B-121511		Asbestos Sampling using SOP-2015	11:15	12:15	317.0	1855121	n-Isokinetic samp	28.8	380										
	inside																		
Ambient air			9:45	12:15												644	0		
EX-IMP LT Blank-01-021712		Impinger sampling Method for Asbestos	9:45	10:45	1170.9	2042686	100	28.8	1404	153	117	437	191	116	117	732	0	88	0
EX-PM LT Blank-01-021712		Total PM sampling using EPA Method 5	9:45	10:45	1149.9	2038362	100	28.8	1379	153	117	437	191	116	117	732	0	88	0
EX-PM2.5 LT Blank-01-021712		PM 2.5 Sampling using EPA 201a	9:45	10:45	750.4	2045959	110	28.7	895	153	117	437	191	116	117	733	0	88	0
EX-MCE LT Blank-01-021712	orch O	Asbestos Sampling using SOP-2015	9:45	10:45	508.2	2063102	101	28.8	606	153	117	438	191	116	117	733	0	88	0

EX-HT-CEM Final Analysis. XI8XI
Summary Sheet for HT-tests

Test ID	Sampling train Type	Start Time	End Time	Sample Volume	Total Flue gas Volume	Isokineticity	Moelcuar weight	Sample Mass	Temperature at the grate				Temperature 4 inches above the grate		Average CO_2	Average CO	Delta CO2	Delta CO	CO_2 generated from the bu	CO generated from the burn	Mass of Carbon generated from the burner or D		Mass of Duff inserted	Mass of ash remaining	Mass loss using the scale
		EDT		Dry Standard Liters			g/gmole	Grams	T1	T2	T3	T5	T4	T6	ppmv				ppmv		sampled	Total	Total	After 24 hours smoldering	During testing
Air sampling		10:00	10:15						8	8	5	8	6	8	644	6								grams	
Pre-Duff sampling		14:15	14:40				28.8		712	791	919	562	493	442	1852	7.50	1208	1	1843	1.2	0.00				
EX-HT-IMP-01-121911	Impinger sampling Method for Asbestos	14:40	15:40	1152.21	2.06E+06	97	28.8	1429	874	810	829	717	556	530	3717	75	1865	68	2845	65.8	1.15	1950	5081	2379	NA
EX-HT-PM-01-121911	Total PM sampling using EPA Method 5	14:40	15:40	1229.57	1.83E+06	101	28.8	1474	878	810	829	717	556	530	3717	75	1865	68	2845	65.8	1.19	1760			
EX-HT-PM2.5-01-121911	PM 2.5 Sampling using EPA 201a	14:40	15:40	751.16	1.86E+06	95	28.8	900	878	810	829	717	556	530	3717	75	1865	68	2845	65.8	0.72	1792			
EX-HT-MCE-01A-121911	Asbestos Sampling using SOP 2015	14:40	14:15	76.56	4.79E+05	Non isokinetic sampling	28.8	92	899	858	852	684	574	568	3309	37	1457	30	2223	28.9	0.057	355			
EX-HT-MCE-01B-121911		14:56	15:11	75.64				91	888	799	826	734	582	468	3648	70	1796	62	2740	60.4	0.070	444			
EX-HT-MCE-01C-121911		15:12	15:27	73.63				88	846	782	820	718	532	556	3868	96	2016	88	3076	85.9	0.077	503			
EX-HT-MCE-01D-121911		15:28	15:43	75.55				91	884	804	819	738	430	523	4074	95	2222	88	3390	85.2	0.087	552			
				75.35																					
Air sampling		9:13	9:28						15	15	17	16	16	16											
Pre-Duff sampling		10:52	11:01						785	746	772	572	393	456	1713	0									
EX-HT-IMP-02-122211	Impinger sampling Method for Asbestos	11:05	12:05	1126.87	1.83E+06	106	28.8	1351	857	907	746	753	476	527	2380	58	667	57	1018	55.8	0.41	660	5123	2397	2030
EX-HT-PM-02-122211	Total PM sampling using EPA Method 5	11:05	12:05	1110.08	1.83E+06	102	28.8	1331	857	907	746	753	476	527	2380	58	667	57	1018	55.8	0.40	662			
EX-HT-PM2.5-02-122211	PM 2.5 Sampling using EPA 201a	11:05	12:05	753.16	1.83E+06	108	28.8	903	857	907	746	753	476	527	2380	58	667	57	1018	55.8	0.27	661			
EX-HT-MCE-02A-122211	Asbestos Sampling using SOP 2015	11:05	11:20	74.87	4.57E+05	Non isokinetic sampling	28.8	90	845	931	700	726	542	560	2143	21	430	21	656	20.3	0.017	103			
EX-HT-MCE-02B-122211		11:21	11:36	78.92				95	839	909	759	755	418	506	2328	46	615	46	938	44.8	0.026	151			
EX-HT-MCE-02C-122211		11:37	11:52	75.95				91	858	901	763	764	449	520	2424	74	710	74	1084	71.6	0.030	179			
EX-HT-MCE-02D-122211		11:53	12:08	82.62				99	890	877	761	769	519	531	2692	98	979	98	1493	95.0	0.044	246			
				78.09																					
Air sampling		8:49	9:15						5	5	5	6	6	6											
Pre-Duff sampling		10:09	10:14						659	756	939	804	546	484	1342	0									
EX-HT-IMP-03-122811	Impinger sampling Method for Asbestos	10:16	11:16	1038.46	1.86E+06	99	28.8	1245	888	832	936	776	582	596	2674	61	1332	61	2033	59.2	0.72	1292	5255	2329	2211
EX-HT-PM-03-122811	Total PM sampling using EPA Method 5	10:16	11:16	1119.76	1.88E+06	100	28.8	1342	888	832	936	776	582	596	2674	61	1332	61	2033	59.2	0.78	1305			
EX-HT-PM2.5-03-122811	PM 2.5 Sampling using EPA 201a	10:16	11:16	769.40	1.86E+06	109	28.8	922	888	832	936	776	582	596	2674	61	1332	61	2033	59.2	0.53	1294			
EX-HT-MCE-03A-122811	Asbestos Sampling using SOP 2015	10:16	10:31	48.44	4.66E+05	Non isokinetic sampling	28.8	58	955	851	974	818	606	615	2237	11	895	11	1366	10.7	0.022	211			
EX-HT-MCE-03B-122811		10:34	10:49	75.58				91	934	840	929	757	565	553	2548	41	1207	41	1841	39.8	0.047	290			
EX-HT-MCE-03C-122811		10:50	11:05	78.72				94	846	833	953	768	574	588	2844	86	1502	86	2293	84.0	0.062	370			
EX-HT-MCE-03D-122811		11:06	11:21	70.76				85	763	781	846	753	597	603	3236	127	1894	128	2890	124.0	0.071	470			

EX-LT-CEM-Final Analysis.xlsx
Summary Sheet for LT Tests

Test ID	Sampling train Type	Start Time	End Time	Sample Volume	Total Flue gas Volume	Isokinetic rate	Moelcuar weight	Sample Mass	Temperature at the grate (°C)						Duct Temperature Degree C	Average CO_2	Average CO	Delta CO2	Delta CO	$CO_{2\,generated\,from\,Duff}$	$CO_{generated\,from\,the\,Duff}$	Mass of Carbon generated from the Duff		Mass of Duff inserted	Comments
		EDT		Dry Standard Liters		%	g/gmole	Grams	T1	T2	T3	T4	T5	T6		ppmv				ppmm		sampled	Total	Total	
Ambient air		10:55	11:05						9	9	9	9	9	9	9	426	10						grams		
Pre-Duff sampling (Torch Only)																									
EX-LT-IMP-02-021412	Impinger sampling Method for Asbestos	11:05	12:05	1187.5	2.13E+06	97	28.8	1423	388	26	323	298	395	364	22	604	28	The Torch emissions were not taken to determine the mass of carbon burned from Duff only						2542	NO CEM data for torch only
EX-LT-PM-03-021412	Total PM sampling using EPA Method 5	11:05	12:05	1187.4	2.14E+06	99	28.8	1423	388	26	323	298	395	364		604	28								
EX-LT-PM2.5-03-021412	PM 2.5 Sampling using EPA 201a	11:05	12:05	745.0	2.13E+06	92	29.0	898	388	26	323	298	395	364		604	28								
EX-LT-MCE-03A-021412	Asbestos Sampling using SOP 2015	11:05	11:20	139.6	5.41E+05	106	28.7	167	216	46	229	135	132	135	25	708	24							636	
EX-LT-MCE-03B-021412		11:21	11:36	127.8	5.34E+05	98	28.7	153	450	21	378	359	488	446	23	608	36							845	
EX-LT-MCE-03C-021412		11:37	11:52	127.4	5.30E+05	98	28.7	152	441	19	351	349	480	440	21	569	28							641	
EX-LT-MCE-03D-021412		11:54	12:09	126.1	5.28E+05	98	28.7	151	442	18	320	343	471	431	20	416	17							630	
Ambient air		9:01	9:03						6	7	7	7	7	7	9	454	12								
Pre-Duff sampling (Torch Only)		10:50	11:10						127	13	135	118	101	128	33	916	0								
EX-LT-IMP-03-021512	Impinger sampling Method for Asbestos	11:10	12:10	1189.0	2.09E+06	99	28.8	1425	225		340	283	203	205	46	1542	41	626	41	956	39.8	0.40	697	2485	
EX-LT-PM-03-021512	Total PM sampling using EPA Method 5	11:10	12:10	1167.3	2.10E+06	99	28.8	1399	225		340	283	203	205	46	1542	41	626	41	956	39.8	0.39	699		
EX-LT-PM2.5-03-021512	PM 2.5 Sampling using EPA 201a	11:10	12:10	753.7	2.09E+06	95	29.0	909	225		340	283	203	205	46	1542	41	626	41	950	39.6	0.25	696		
EX-LT-MCE-03A-021512	Asbestos Sampling using SOP 2015	11:10	11:25	105.5	3.44E+04	81	28.8	126	74	16	106	199	55	77	38	1055	2	139	2	212	2.0	0.01	2	641	
EX-LT-MCE-03B-021512		11:28	11:43	132.0	4.33E+04	102	28.8	158	105	20	323	260	81	98	44	1349	28	433	28	661	27.5	0.03	10	630	
EX-LT-MCE-03C-021512		11:42	11:57	127.8	4.22E+04	99	28.8	153	330	22	506	331	320	307	50	1854	66	939	66	1433	64.5	0.06	21	629	
EX-LT-MCE-03D-021512		11:58	12:13	127.7	4.25E+04	100	28.8	153	449	24	493	371	423	398	52	2103	83	1187	83	1811	80.8	0.08	27	585	
EX-LT-MCE-02E-021512		12:15	12:30	131.1	4.23E+04	100	28.8	157	443	24	436	387	476	446	28	869	68	415	55	633	53.9	0.03	10	0	
Ambient air		8:05	8:20						8	8	8	8	8	8	8	466	0						22		
Pre-Duff sampling (Torch Only)		9:36	9:40						127	103	143	158	107	139	24	629	0						#DIV/0!		
EX-LT-IMP-03-021612	Impinger sampling Method for Asbestos	9:40	10:40	1136.9	2.04E+06	97	28.8	1363	306	152	486	488	236	251	33	818	0	189	0	289	-0.3	0.11	0	2568	
EX-LT-PM-03-021612	Total PM sampling using EPA Method 5	9:40	10:40	1142.8	2.05E+06	99	28.8	1370	306	152	486	488	236	251	33	818	0	189	0	289	-0.3	0.11	193		
EX-LT-PM2.5-03-021612	PM 2.5 Sampling using EPA 201a	9:40	10:40	747.9	2.04E+06	96	28.8	897	306	152	486	488	236	251	33	818	0	189	0	289	-0.3	0.07	193		
EX-LT-MCE-03A-021612	Asbestos Sampling using SOP 2015	9:40	9:55	127.0	5.19E+05	100	28.8	152	143	43	408	312	61	99	28	681	3	52	2	79	2.3	0.003	14	640	Aborted sample, filter torn
EX-LT-MCE-03B-021612		9:56	10:11	134.4	5.15E+05	107	28.8	161	336	93	545	613	228	269	31	799	14	170	14	259	13.3	0.012	47	643	
EX-LT-MCE-03C-021612		10:13	10:28	124.3	5.14E+05	99	28.8	149	366	198	487	511	325	311	35	927	22	298	21	124	20.9	0.006	21	641	
EX-LT-MCE-03D-021612		10:29	10:44	132.6	5.14E+05	106	28.8	159	392	317	497	508	354	341	37	857	32	228	32	46	30.7	0.004	9	644	
EX-LT-MCE-03E-021612		10:46	11:01	131.1	5.24E+05	103	28.8	157	396	419	505	542	431	381	19	530	19	64	19	2	18.5	0.001	0	0	

12-22-11 Ash.xlsx
Sheet 1

Ash Weight

Jar #	Jar Weight, g		Jar Weight With Ash, g		
#1	495.1		1086		
#2	495.8		990.9		
#3	495.5		901.6		
#4	496.3		973		
#5	495.6		923.5		
Total	2478.3	Total	4875	Weight of Ash, g	2396.7

12-19-11 TC and Ash.xlsx
Sheet 1

Thermocouple Probe IDs

PDAQ	TC ID
A (#1)	TE103
B (#2)	TE102
C (#3)	TE???
D (#4)	TE203
E (#5)	TE202
F (#6)	TE201

Ash Weight

Jar #	Jar Weight, g		Jar Weight With Ash, g		
#1	490.5		1073.9		
#2	496.1		921.9		
#3	496.0		588.5		
#4	490.5		1022.6		
#5	495.8		866.4		
#6	495.6		870.4		
Total	2964.5	Total	5343.7	Weight of Ash, g	2379.2

Low Temp Ash. xlsx
Sheet 1

Ash Weight

Low Temp 02/14/2012

Jar #	Jar Weight, g		Jar Weight With Ash, g		
#1	504.7		924.9		
#2	504.1		805.3		
#3	492.9		655.1		
#4	502.0		708.2		
Total	2003.7	Total	3093.5	Weight of Ash, g	1089.8

Low Temp 02/15/2012

Jar #	Jar Weight, g		Jar Weight With Ash, g		
#1	503.9		774.9		
#2	503.6		819.2		
#3	502.5		704		
#4	503.6		632		
Total	2013.6	Total	2930.1	Weight of Ash, g	916.5

Low Temp 02/16/2012

Jar #	Jar Weight, g		Jar Weight With Ash, g		
#1	491.0		809.1		
#2	490.8		797.5		
#3	491.0		775.3		
#4	490.7		765.1		
Total	1963.5	Total	3147	Weight of Ash, g	1183.5